THE PHILOSOPHICAL MAGAZINE, OR ANNALS OF CHEMISTRY, MATHEMATICS, ASTRONOMY, NATURAL HISTORY, AND GENERAL SCIENCE.

BY

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AND

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"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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ALERE FLAMMAM

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ERRATA.

Page 220, line 11 & 12, *omit* the sentence " and the scene of the fabulous adventures of Robinson Crusoe."

Page 220, line 20, *for* " metastique [?]," read " *chaux carbonatée metastatique*."

Page 331, line 14, *for* Sarne *read* Larne.

Page 332, line 30, *for* Sarne *read* Larne.

Page 332, line 31, *for* William Temrent, Esq. *read* William Tennent, Esq.

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

JANUARY 1831.

I. *Reply to a Note in the* Rev. Mr. Conybeare's *Paper entitled "An Examination of those Phænomena of Geology, which seem to bear most directly on theoretical Speculations."* *By* C. LYELL, *Esq. F.R.S. For. Sec. G.S. &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I OBSERVE in the first page of your last Number (December 1830) the following passage, in a paper by my friend the Rev. W. D. Conybeare: "While on classical subjects, I would just remark how much I am gratified by finding *every quotation* in Mr. Lyell's able remarks on the attention of the ancients to geology, *identical* with those previously given in my own Outlines, with the single exception of the passage from Strabo, to which, however, I have given a reference although certainly partial and imperfect: as there is not a word of acknowledgement, of course this coincidence is accidental."—Surprised at this unexpected charge, I immediately compared the second chapter of my "Principles of Geology" with those two pages of the introduction to the "Outlines," (pp. 38, 39,) which comprise the whole of Mr. Conybeare's allusions to the geological doctrines to be met with in the writings of classical antiquity. The authors cited in those pages are Aristotle, Lucretius, Seneca, Plutarch, Pliny, Herodotus, Polybius, Strabo, Pausanias, Xenophon, Theophrastus, and Ovid. Of these twelve, five only are to be found among the classical authorities adverted to by me; viz. Aristotle, Seneca, Pliny, Strabo, and Ovid. The passages which

which I have cited from Aristotle and Seneca relating to the supposed periodical revolutions of the globe, had been previously collected and commented upon in Dr. Prichard's "Egyptian Mythology," a work to which I have been careful to refer in no less than four places in my second chapter, and to which Mr. Conybeare has also acknowledged his obligations in his Introduction (p. 39). In regard to other citations from Aristotle's Meteorics, besides that they must be familiar to all who are at once scholars and naturalists, Mr. Conybeare can hardly be ignorant that they have been referred to again and again, not only in the works of the early Italian writers on geology, but also by Hooke, Ray, and Burnet *, the last-mentioned of whom has given a translation of the passage in the Meteorics, lib. 1. 14. to which Dr. Prichard and Mr. Conybeare refer. An enumeration of all the passages in Pliny relating to the birth of new islands and analogous subjects is to be found in Raspe's work †; but even Raspe lies open to an accusation from Mr. Conybeare of having copied his citations from previous writers, and among others from Hooke. The last-named philosopher has called attention to the same notices by Pliny on the formation of new lands by river-alluvions, to which Mr. Conybeare refers ‡. The learned mathematician has moreover enlarged §, as well as Whiston ‖ after him, on "the burying of Typhœus under Etna," and other mythological stories of the gigantomachia; and passages on this subject from Pindar, Sophocles, Plutarch, Apollodorus, Virgil, Ovid, Lucan, and several others, are quoted by these writers, many of which allusions have been revived by some of the learned of our days, and perhaps regarded by them in the light of original discoveries in the mines of classic lore.

The only passage in Strabo mentioned in the "Outlines," is one not alluded to by me, but which had been already given at full length by Raspe more than sixty years before, in his copious extracts from the writings of the ancients on volcanic phænomena; but I have looked in vain for that "partial and imperfect reference" which Mr. Conybeare says may be traced in his own two pages to that doctrine of Strabo respecting elevation by earthquakes, of which I have endeavoured to point out the importance.

Is it then the trite quotation from the Metamorphoses of Ovid which has laid me open to so sweeping a charge of plagiarism?

* Sacred Theory of the Earth, vol. i. p. 214.
† *De Novis Insulis,* 1763.
‡ Hooke's Discourse of Earthquakes: Posthumous Works, p. 299.
§ Ibid. p. 323.
‖ New Theory of the Earth, &c. p. 201.

giarism? I should have owed an apology to my readers for pretending to recall to their minds that celebrated passage so hackneyed by repeated references in the works of Fabio Colonna, Hooke, Moro, Generelli, Ray, Vallisneri, Fortis, and others, had not all those writers in common with Mr. Conybeare neglected to give a full and connected view of the Pythagorean system as developed in the memorable verses of the Roman poet.

I have scrupulously stated, in my "Principles of Geology*," Hooke's acquaintance with the learned Italian writers who preceded him, as well as his allusion to Strabo and other classical authorities†; and I have not been silent respecting the erudition of Moro‡, and several of his successors. The notions of Theophrastus respecting fossils are discussed by Fabio Colonna§, and alluded to by Scilla‖; and the various references to Plutarch and Lucretius in the treatises of the early geologists are known to those who are versed in the history of the science. No less rich are the various writings of Fortis in classical citations bearing on geology. Mr. Conybeare is surely aware that his predecessors had left no field open wherein geologists of his day might display their scholarship, unless they availed themselves of a more enlarged acquaintance with natural phænomena to form a juster estimate of the relative value of facts and theories recorded by the ancients. The estimate of their importance given by me in the "Principles of Geology" is somewhat different from that to which Mr. Conybeare inclines; for I have been disposed to refer to observation and inductive reasoning the origin of those crude speculations which in the "Outlines" are attributed "to principles assumed on the high *priori* road."

Your readers will, perhaps, think that these rival claims to priority to half a dozen classical common-places are unworthy of the cultivators of a science which more than any other is marked by the daily discovery of grand and unexpected truths in physical science, especially as the initiator of this discussion ranks high as an original observer: but I feel that I should presume too much on the acquaintance of the public with my work, and regard too little the weight of an assertion made by Mr. Conybeare, if I allowed the statement in his note to pass without observation.

2, Raymond Buildings, Gray's Inn,
Dec. 5th, 1830.

* Principles of Geology, p. 32. † Ibid. p. 34. ‡ Ibid. p. 42.
§ *De Glossopetris, &c.* ‖ *De Corporibus Marinis*, p. 41.

II. *Memoir of the late* J. S. Miller, *A.L.S. Curator of the Museum of the Bristol Philosophical Institution. By* A Correspondent.

MR. J. S. MILLER was a native of Dantzig, the only son of truly respectable parents. He was designed by his father for commercial pursuits, and served an apprenticeship with M. Dennies, a merchant of his native town. He came to England in 1801, with a full resolution of proceeding to America, and with letters of recommendation to persons in that country. The vessel in which he expected to cross the Atlantic had sailed on the day before his arrival; and being thus detained in Bristol, he formed connections by which he was finally induced to alter his purpose and to fix his abode in this city. Here he endeavoured to establish himself in mercantile business, but his efforts were unsuccessful; and it happened, unfortunately for his prospects in life, that Dantzig was at this period overrun and pillaged by the French. His father's property shared the common fate; and of fifteen hundred pounds which had been left to Mr. Miller, nothing ever came into his possession except a box of valuable coins, which was concealed during two years in a church, and a very inconsiderable sum of money. He now devoted himself entirely to scientific pursuits, for which he had shown a strong inclination from his early youth, and he soon acquired very extensive information in various branches of natural history. Some curious researches in entomology introduced him at an early period to the acquaintance of Dr. Leach, and this was the first occasion on which his talents became known beyond the circle of his personal friends. The prospect of succeeding Dr. Leach at the British Museum opened a new field to his mind; and although he was frustrated in this expectation by the appointment of Mr. Children, he applied himself from this time with increased energy to his researches in natural history. An investigation of the structure and nature of the organic remains of the *Encrinus*, for which the vicinity of Bristol affords so remarkable a field, now became his favourite pursuit. It was while he was engaged in the publication of his well-known work on the *Crinoïdea*, that he became known to the Rev. W. D. Conybeare, by whom his merit was soon distinguished and very highly appreciated. As the work was going through the press, Mr. Conybeare kindly undertook to revise it, and, by correcting the peculiarities of a foreign idiom*, to render

* This, however, was strictly confined to the correction of such idiomatic inaccuracies as might have obscured the sense to an English reader; in all other cases it was considered in every respect desirable scrupulously to preserve unaltered the author's own expressions.—W. D. C.]

render it more acceptable to the public than it might otherwise have been. In this publication Mr. Miller had to surmount many difficulties; and although it became the means of spreading universally his reputation as a profound and accurate naturalist, it was to him a source not only of present expense, but of ultimate pecuniary loss. This may be attributed in part to his great liberality of disposition. I am informed that he gave away not less than a hundred copies of his work, principally to individuals whom he supposed unable to purchase it. His pen was always ready and his services energetic in any scientific undertaking in which they were requested, as the many letters of thanks and works presented to him in consequence of such assistance will sufficiently testify. Notwithstanding the difficulties he experienced at his first publication, he was not discouraged. He contemplated and had arranged in his mind the materials for a second work on Fossilized Corals, and likewise an Appendix to that on the *Crinoïdea.* There was scarcely a department of natural history to which he had not directed his mind with zealous and intense application; and there is no doubt that he would have achieved more, as an original discoverer, than he has actually performed, if his time and exertions had not been engrossed, during the last years of his life, by his occupations in the Museum of the Philosophical Institution of Bristol, of which he was the Curator from the period of its establishment.

Mr. Miller's constitution of body, though not robust, was healthy, and during a period of twenty-seven years he had never a day of severe indisposition. His cheerfulness and temperance were remarkable. The unceasing activity of his mind was apparently too great for the physical energy of his body; and the confinement to which he was of necessity subjected, in consequence of his appointment in the Institution, probably contributed to undermine his health, which began to give way about three years before his death. He was married in the year 1806, and has left a widow and three sons.

As a naturalist, Mr. Miller was well fitted by the habits of his mind to cooperate in the researches of an age, of which it is the peculiar merit to obviate the reproaches once, perhaps, justly cast, against mere systems of classification, and to found such arrangements upon the just and philosophical grounds afforded by the exact determinations of science, and the general principles of physiology and comparative anatomy. The labours of Baron Cuvier may be cited as the great model in this line; but among those who in this country have followed the same course, the subject of the present memoir assuredly deserves very favourable mention. To an acuteness

ness of mind which readily seized on general relations, he joined the most indefatigable patience of laborious investigatión,—a quality particularly requisite in the branch to which he especially directed his attention; viz. the elucidation of the history of the organic remains which are preserved in our strata in a fossilized state. In this state individual specimens generally occur in a more or less imperfect condition, so that the real type of the organization can seldom be ascertained without the most careful comparison of many particular relics. They are likewise in many instances so imbedded in the solid rock, that the most essential parts are concealed, and cannot be detected without the nicest dexterity of manual operation. When these circumstances are taken into the account, we may fairly appreciate the labour and talent necessary to produce such a work as Mr. Miller's account of the fossil *Crinoïdea*. This family of organic bodies, from the delicate beauty and interesting character of many of its specimens, had long excited the attention of naturalists; but still our whole knowledge on the subject, previously to the appearance of Mr. Miller's work, was in the highest degree vague and indeterminate. His researches, however, have established in the most complete manner, and have placed in every respect in the fullest and clearest light, the whole history and relations of this curious family. He has demonstrated its arrangement into four divisions, including nine genera, and more than twenty species. Of each species he has developed the whole anatomy with the same exactness as if they had been recent objects easily preserved, overcoming the many and great obstacles which, as it has been already noticed, the fossilized state presents to such inquiries. Persons who are at all aware of the complicated structure of the *Crinoïdea*, and the numerous articulations which enter into the composition of each individual, must feel all the arduousness of such a task; but those only can fully appreciate the extreme care with which it has been performed, who have had an opportunity of examining Mr. Miller's collection of original specimens now deposited in the Museum of the Bristol Institution, and of comparing these with the illustrations published in his work.

The great merit of this treatise secured its immediate reception as the standard work on the subject, by all the scientific writers interested in similar pursuits on the continent as well as in this country; and reference is now uniformly made to it as such. The author had intended to follow up this work, as before mentioned, by a similar examination of our Coralline remains; but it is feared that he has left no papers on

on this branch at all prepared for publication. A paper of his, published in the Transactions of the Geological Society, contains very valuable contributions towards the history of our fossil Belemnites, and has been most favourably referred to by the French author who has subsequently published the standard monography of that department.

Mr. Miller's talents have been highly estimated by the ablest of our naturalists and geological writers. Professor Blumenbach, Baron Cuvier, MM. Latreille and D'Aubigné, have expressed in letters to him high commendation of his works. Professor Buckland obtained his assistance in arranging the valuable collection of organic remains belonging to the Ashmolean Museum at Oxford. The same Professor, in his very interesting paper on the recent discovery in this country of fossil remains belonging to the flying reptile the *Pterodactylus*, mentions that Mr. Miller first suggested to him the possibility, thus confirmed, that the fossil bones commonly supposed to belong to birds really appertained to that animal. And Mr. Conybeare, while drawing up the lists of the organic remains in our strata, which are given in his "Outlines," was in the common habit of appealing to Mr. Miller's authority.

In surveying the results of Mr. Miller's scientific acquirements and of his exertions, we must not forget the important benefits rendered by him to the Museum of the Institution of which he was Curator. It may safely be affirmed, that the history of similar collections does not present another instance in which so rapid a progress has been made in accumulating the varied stores connected with such undertakings; and the rapidity of this progress must undoubtedly be ascribed in a great measure to the energy and zeal of the Curator in the service, and to the interest which he so well knew how to communicate to those with whom he came into intercourse.

III. *On the theoretical Determination of the Motion of Fluids. By the Rev.* J. Challis, *Fellow of Trinity College, Cambridge, and of the Camb. Phil. Soc.**

SUPPOSE x, y, z, to be the coordinates of any particle of a fluid mass in motion, at a given time t, and u, v, w, the velocities of the particle in the directions of the axes of x, y, z, respectively, at that time. The general investigation of the motion of fluids conducts to a case of very extensive application, in which $u\,dx + v\,dy + w\,dz$ is a complete differential of a function of x, y, z, which may also contain t. In a communication

* Communicated by the Author.

nication to the Phil. Mag. and Annals of Philosophy for August 1829, which contained several inaccuracies, I made an assertion respecting this case of fluid motion, the correctness of which subsequent consideration has only tended to confirm; viz. that when $u\,dx + v\,dy + w\,dz$ is an exact differential, the whole motion is such that the motion of each elementary portion of the fluid is directed to a fixed or moveable centre. The course of the reasoning by which this proposition may be established is I conceive such as follows. We know from the theory of partial differential equations, that their integrals, whether we can obtain them exactly or not, must contain arbitrary functions. The arbitrariness of which we are informed by pure analysis, has a signification in the applications of the functions to physical questions. Thus the existence of *arbitrary* functions in the integrals of the equations which determine the motion of fluids, is the proper proof that we can give to the fluid any motion we *please;* and this is an evident consequence of one of the fundamental principles in the investigation of the motion,—the perfect mobility of the particles. The forms of the functions depend on the particular motion we choose to give to the fluid by vessels, pipes, or other means. But however irregular we may cause the motion to be, it may still be conceived to be composed of elementary motions, which obey the law of continuity, independently of our will, just as a line, however broken and irregular, may be conceived to be made up of elementary portions which are straight lines. Absolute discontinuity is inconceivable. The law of these motions will be independent of time and position, and dependent only on the nature of the fluid. Hence, to learn whether the motion be really so composed, it will be necessary, after having obtained the complete integral of the equation expressing the continuity of the fluid, to ascertain whether the arbitrary functions which the integral contains, can be shown to have a particular form, when discussed on the supposition that the origins of the time and coordinates are not fixed. This will in general require the solution of a functional equation. An instance of this reasoning was given in the communication above mentioned, for the case in which the motion is in space of two dimensions. From the complete integral of $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} = 0$, a particular form of the arbitrary functions was obtained, which indicated that the velocity was directed to a centre and varied inversely as the distance from the centre. I have since found that the complete integral of $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} + \frac{d^2\phi}{dz^2} = 0$, which M. Poisson has expressed by definite integrals (*Mém. de l'Acad.*

l'Acad. des Scien. Ann. 1818), also conducts to a particular form of the arbitrary functions, when treated according to the same principles: and from the discussion it appears that ϕ has the same value as would be obtained by integrating $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} + \frac{d^2\phi}{dz^2} = 0$, on the supposition that ϕ is a function of $\sqrt{x^2 + y^2 + z^2}$ or r, and t; in which case the velocity is directed to or from a centre, and varies inversely as the square of the distance from the centre. The instances in which $u\,dx + v\,dy + w\,dz$, or $d\phi$, is known not to be a complete differential of a function of x, y, z, confirm the view here taken. When a mass of incompressible fluid revolves uniformly, without changing form, about a fixed axis, $d\phi$ is not an exact differential; and it is plain that the motions of elementary portions of the fluid are not directed to fixed or moveable centres, because the whole mass moves in such a manner that it may be considered solid. Again, Euler has shown that $d\phi$ is not an exact differential, when a mass of incompressible fluid revolves round a fixed axis, and the velocity is any function of the distance from the axis, and yet that the general equations are satisfied by this case of motion. We may in this instance conceive the fluid to be divided into portions, included between cylindrical surfaces indefinitely near each other, having in common the axis of revolution: the motion of each portion will be the same as if it were solid. No part of the motion will be such as is directed to a fixed or moveable centre, that is, the motion will not be that which peculiarly belongs to fluids.

The principle I have endeavoured to establish, will only in particular cases facilitate the solution of hydrodynamical problems, on account of the difficulty of ascertaining the centres to or from which the motion is directed. The following example, selected for illustration, may perhaps be interesting; because no principles, that I am aware of, have hitherto been advanced by which such a problem could be solved.

Water contained in a conical vessel, the axis of which is vertical, descends with its upper surface always horizontal: It is required to find the velocity and direction of the velocity at any given point in the interior of the fluid mass at a given time, when the velocity of the descending surface is given.

In this example, all the particles must be moving in vertical planes passing through the axis of the cone: hence the centres to which the motion is directed, must be situated in the axis. The integral of $\frac{d^2\phi}{dx^2} + \frac{d^2\phi}{dy^2} + \frac{d^2\phi}{dz^2} = 0$, supposing ϕ to be

 a function

a function of r and t, is $\phi = \frac{\mathrm{F}(t)}{r} + f(t)$, and the velocity $\omega = \frac{d\phi}{dr} = -\frac{\mathrm{F}(t)}{r^2}$. From what has been said, these expressions for ϕ and ω will apply to any point of a mass of fluid, moving so that $d\phi$ is an exact differential. But in general $\mathrm{F}(t)$ and $f(t)$ can be considered constant at a given time only for values of r restricted within limits indefinitely near each other. Let r' be a value indefinitely near to r. Then $\phi' - \phi = \mathrm{F}(t)\left(\frac{1}{r'} - \frac{1}{r}\right) = -\frac{\mathrm{F}(t)}{r^2}\cdot(r'-r) = \omega\,(r'-r)$.

Here $r'-r$ may be considered the increment ds of a line s, drawn continually in the direction of the motions of the particles through which it passes. Hence $d\phi = \omega\, ds$; and $\phi = \int \omega\, ds + \chi(t)$, the integral being taken in regard to an arbitrary portion of the line s. The two expressions for ϕ thus obtained, have a relation to each other, analogous to that between the two expressions which the general and the particular solutions of a differential equation of the first order give for the same variable. By equating these values of ϕ,

$$\frac{\mathrm{F}(t)}{r} + f(t) = \int \omega\, ds + \chi(t)$$

$$\therefore\ \omega = -\frac{\mathrm{F}(t)}{r^2} = -\frac{(\int)\,\omega ds}{r} - \frac{\chi(t) - f(t)}{r}.$$

But in the example before us, if $y =$ the distance of any point from the axis, r, being the length of the portion of a tangent to s intercepted between the point and the axis, will be $y\frac{ds}{dy}$. Therefore,

$$\omega = -\frac{dy}{y\,ds}\left(\int \omega\, ds + \chi(t) - f(t)\right)$$

or, $$-\frac{dy}{y} = \frac{\omega\, ds}{\int \omega\, ds + \chi(t) - f(t)}$$

Hence $\frac{c}{y} = \int \omega\, ds + \chi(t) - f(t)$; and $\therefore\ \omega = -\frac{c\,dy}{y^2\,ds}$.

Now the particles in contact with the surface of the cone must move in straight lines directed to its vertex: and if 2α = its vertical angle, $\frac{dy}{ds} = \sin\alpha$. Hence $\omega = -\frac{c\sin\alpha}{y^2}$; that is, the velocity varies inversely as the square of y, and consequently inversely as the square of the distance from the vertex. Therefore if we conceive a conical surface to have the same vertex and axis as that which contains the fluid, and to have a vertical angle, less by an indefinitely small angle than 2α, the fluid contiguous to the containing surface will move as if included

included between the two surfaces. Similar reasoning may be applied to the fluid contiguous to this new containing surface, and so on throughout the whole of the mass. From this we infer that the motion is at every point directed to the vertex of the given cone. Also, let V = the velocity of the vertical descent of the horizontal surface, and h its distance from the vertex of the cone, and let us consider a point on this surface, at which the direction of the velocity makes an angle θ with the axis. The velocity at this point $= V \sec\theta$ and $V \sec\theta = -\frac{c}{y^2} \cdot \frac{dy}{ds} = -\frac{c \sin\theta}{h^2 \tan^2\theta}$. Hence $-c = \frac{h^2 V \sin\theta}{\cos^3\theta}$. Therefore in general $\omega = \frac{V \sin^2\theta}{\cos^3\theta} \cdot \frac{h^2}{y^2}$. If $\varrho =$ the distance of any point from the vertex $\varrho \sin\theta = y$, and

$$\omega = \frac{V h^2}{\cos\theta} \cdot \frac{1}{\varrho^2 \cos^2\theta}.$$

As the vertical velocity $\omega \cos\theta$ varies as $\frac{1}{(\varrho \cos\theta)^2}$, it is the same at all points of a plane perpendicular to the axis. Hence the fluid descends in parallel slices; that is, a portion which at any instant is included between horizontal planes will always be included between horizontal planes.

Trin. Coll. Camb. Nov. 13, 1830.

IV. *Remarks on the Geology of the Banks of the Tweed, from Carham, in Northumberland, to the Sea Coast at Berwick. By* N. J. WINCH, *Esq. Secretary of the Natural History Society of Newcastle-upon-Tyne*.*

THE rocky strata which border the Tweed from Carham Bourn, where the river begins to form the boundary between Northumberland and Scotland, to the sea shore at Berwick, appearing to be associated in a manner so different from the order generally considered by geologists as the natural arrangement, will oblige me to abstain from theory altogether in the following remarks. It is, therefore, my intention to lay before the Society merely a series of notes lately made during an examination of the north-eastern termination of our district, accompanied by specimens which will serve to assist in verifying the correctness of the observations. A superficial view of the banks of this beautiful river presents a succession of eminences, I can scarcely call them hills, chiefly composed of diluvium, con-

* Read before the Natural History Society of Newcastle-upon-Tyne, on the 20th of July last; and now reprinted from the Transactions of that Society.

taining numerous basaltic boulders, water-worn, as usual. This soil is red; but colour does not always indicate the nature of the rocks below, for a red soil also covers the porphyries and sienites of the north of England and the south of Scotland. By a cut on the side of the road immediately beyond Coldstream Bridge, the incumbent mass of loose earth is shown to be not less than fifty feet thick, at that spot, from the top of the bank to the road, and for fifty feet more, to the brink of the stream, no rock is seen to crop out from under the debris; and subsequent remarks led me to think that this part of the country was generally clothed by a diluvial soil of considerable thickness. To avoid repetition, it may not be amiss to enumerate the rocks which are the subject of these notes. Excluding basalt, they are all stratified, and, with few exceptions, dip towards the southward of east, but at very different angles, some beds rather exceeding than falling short of 45°. The suite comprises dolomite, indurated marl, and limestone containing gypsum, red and variegated sandstone, with nodules of red ochre, bituminous shales and sandstones, with vegetable remains, encrinal limestone, also with vegetable exuviæ, shale, with bivalve shells, and numerous beds of coal; the whole series appearing to rest upon transition rocks, which, to the north-west and south-west form the Lammer Muir and Cheviot range of mountains.

At the distance of sixteen miles, in a direct line from the sea, and in the vicinity of Carham, a small burn enters the Tweed on its south side, dividing Northumberland from Roxburghshire. Here a bed of close-grained iron-gray basalt occupies the bed of the river for a considerable distance, and near Carham Church rocks of pale-brown dolomite may be seen on its banks. This limestone seems to be superior to the basalt, and is heaped together in irregular masses, but that these are a part of a regular stratum is evident, for at Haddon Rigs, a mile south from this place, the stone is quarried to the depth of ten feet for agricultural purposes, though, from the veins of reddish-brown chert which pervade it, the produce of pure lime is much diminished. Besides chert, calcareous spar occurs in the rock, which, at the quarry just noticed, is about ten feet thick, with a covering of ten feet of soil. The next point where rocks are exposed to view is on the north side of the river; at the foot of Spring Hill, about a mile west of Birgham. Here numerous thin strata of soft arenaceous limestone, of an ash colour, interstratified with greenish-gray indurated slaty marl, mixed with sand and mica, form cliffs of nearly sixty feet high, and the river flows over strata of the same description. In this limestone, veins of flesh-coloured compact

compact gypsum* and nodules with crystals of brownish-red selenite are tolerably abundant. The rocks lie very regular, and dip, at a trifling angle, to the south-east. The relation they bear to the red and variegated sandstones will be noticed when the strata situated lower down the Tweed come under consideration.

In the bed of the rivulet called Firebourn, a slip or dyke is worthy of notice; in the language of miners, it casts up to the east, and the thin strata of limestone and indurated marl, before mentioned, may be seen in the water-course, dipping at an angle of 40° in that direction. On the banks of the river, at a trifling distance lower down, another slip divides the rocks, and brings two beds of micaceous sandstone into contact with the calcareous series; the upper of these sandstone beds is slightly tinged red, owing to its mica being oxidated, but the lower is of a pale yellowish-brown colour, and ambiguous character, rather resembling a coal sandstone; their aggregate thickness, with a thin micaceous parting, is fourteen feet. Half a mile below Firebourn there is a ford across the Tweed, noted in Border History; its direction is south-east, and may have been occasioned by the dyke. On the south side of the river the ruins of Wark Castle stand on an eminence sixty feet high, composed of calcareous strata, similar in every respect to those at Spring Hill, but their dip is in an opposite direction. These impure limestones seldom exceed a foot in thickness, and gypsum is interspersed through them. At about a hundred yards west of the Castle, rocks of dolomite again crop out on the banks of the river, but to the eastward this peculiar mineral was no more to be seen; nor could I thoroughly satisfy myself as to its geological position, though I have every reason to believe that it rests upon the basalt, and suspect this rock belongs to the same bed as occupies the north shore of the Tweed at Carham, and is here again brought to the surface by the Firebourn Dyke.

Again, passing to the north side of the Tweed, near the Temple at the Lees, eight alternations of the same calcareous beds as form the cliffs at Spring Hill and Wark, (except that the lower stratum of limestone contains very minute bivalve shells filled with calcareous spar,) occupy the bank and the bottom of the river; their thickness above ground is about ten feet, and their dip towards the north-west. No strata of this description were again noticed for nearly six miles, and

* Gypsum is also found at Fluers, some miles higher up the Tweed, on its north bank, and has been found by the Rev. A. Baird, on the banks of the Whiteadder, near Hutton Hall.—Geological Essay on Berwickshire, in the Preface of Johnston's Flora of Berwick, p. xxi.

when

when again seen, were found associated with red sandstone, in the vicinity of Norham.

The town of Coldstream stands on what are usually called coal-measures, comprising sandstones and bituminous shales, exactly the same as those of the Newcastle coal-field, and wherever diluvium does not form the shores of the river, these may be traced for the distance of two miles and a half. The little river Leat, which here empties itself into the Tweed, passes through Mill Haugh, where the late Lord Home bored for coal, but to what depth I could not ascertain. An extensive free-stone quarry is worked in this field to the depth of thirty feet; the upper and middle beds are white micaceous sandstone, fine-grained, and full of coal pipes, the lower is free from these vegetable exuviæ*. A strong chalybeate spring rises to the day, and runs into the Leat at a short distance from the quarry. Both above and below Coldstream Bridge the Tweed flows over these coal measures, which dip, at a trifling angle, to the south-east, and the rocks on the south side having been cut through, micaceous sandstone, alternating with bituminous shale, and covered with a bank of red earth, are laid open to view, and beds of the same nature may be noticed half a mile lower down the stream. But the cliff at Lennel Braes, on the north side, two miles to the eastward, exhibits the most perfect section of this suite of strata to be met with in the vicinity. At the Braes the perpendicular cliff extends for more than a hundred yards, and was estimated by me at forty feet in height, exclusive of its diluvial covering, but the correct section, published in Mr. Witham's pamphlet On the Vegetable Fossils found there, makes its elevation forty-four feet†. The uppermost bed is sandstone, which is succeeded by four others, alternating with slaty sandstones, or coal metals and shales inclosing balls of clay iron-stone. Their dip is north-east, and the rocks on the south side of the river appear to resemble them. The petrified trunks of trees are irregularly dispersed through the lower bed of shale, and are both of the monocotyledonous and dicotyledonous classes of vegetables; but for an accurate description of these interesting fossils the pamphlet before mentioned must be referred to. At no great distance east of this escarpment a quarry has been opened on the side of the bank to the depth of twenty feet,

* Sandstones, bearing strong indications of being associated with beds of coal, are quarried at Sprouston, in Roxburghshire; for an account of which see Mr. Buddle's pamphlet "On the search for Coal in a Part of the Counties of Roxburgh and Berwick, in 1806," pp. 10, 11. These sandstones are very hard, and filled with coal pipes.

† Mr. Witham's paper will be found in the Phil. Mag. and Annals, N.S. vol. viii. p. 16.—Edit.

feet, and is situated more than twenty feet above the river. The stone here has a slight tinge of red, similar to the stratum in the upper part of the cliff at Firebourn, which abuts against the calcareous beds. It dips to the southward, and is divided by thin slaty micaceous partings, and capped by about ten feet of loose sand, the abode of flights of sand-martins. On the north side of the Tweed, at the distance of a mile above Twizell Ferry, rocks of well-defined red sandstone make their appearance. It is fine-grained in texture, of a dark reddish-brown colour, and abounds with spangles of silvery mica. The cliff is of considerable elevation, and from hence to the sea coast, thick beds of red and variegated sandstone, at some places covered by the thin calcareous strata previously mentioned, and at others interstratified with them, become prevalent, though coal measures may be noticed in their vicinity. On descending the river until opposite Twizell Boat-House, fine-grained micaceous red sandstone rocks, and those of the coal formation, or at least such as have heretofore been considered exclusively as such, are in close contact. On the north shore, low rocks of the latter description appear *in situ*, and it may be worth remarking, that, on ascending the river Till, for the distance of a mile westward, Twizell Castle may be seen, built on an extremely hard gray micaceous sandstone, filled with coal scars*, and so promising did this neighbourhood appear, as to induce the proprietor to make a trial for coal. Three-quarters of a mile further up the Till, the red rocks are again met with, and worked at Mill Quarry, but at Dunston Haugh, two miles and a half from the Castle, the stratum quarried is yellowish-white, and seemed to be a coal sandstone. But to return to Tweed side. On the south bank, above the Ferry House there is a perpendicular cliff, forty feet high, of white sandstones, though tinged red on their surfaces by the oxidation of their mica; the beds are separated by thin micaceous partings, and in every respect resemble the rock quarried below Lennel. On the north side, just below the ferry, the cliff is not less than 50 feet above the stream, and composed of fine-grained red sandstone, with small scales of silvery mica. On descending the river, the rocks on the south shore continue red, micaceous partings divide the thick strata, through which nodules of red ochre are dispersed in abundance, and those on the north side agree with them in every character.

* Minute fragments of red garnets are embedded in this sandstone; a circumstance I have never noticed in the sandstones of the Newcastle coal-field; but in the millstone grit at Shaftoe Crags, near Wallington, the same mineral was detected by W. C. Trevelyan, Esq., and it abounds in the grauwacke of Bournmouth, north of Berwick. The Twizell sandstone I suspect to be an old member of the carboniferous limestone formation.

Opposite

Opposite Newbiggin, the elevated cliffs are rendered singular by an escarpment of bright red marl, which, from a distance, is a striking object. The dip is towards the south-east. Near Norham Boat-House, the Tweed sweeps round the foot of a promontory of not less than seventy to eighty feet in height; its rocks are red, and differ in no respect from those a little higher up on the north bank of the river. To the eastward, Norham Castle stands upon an eminence overlooking the Tweed, and, as the stones of which it is constructed are red and white, the vicinity of quarries of both these kind of rock is evident; but the geology of its immediate neighbourhood may be studied to most advantage by carefully inspecting the abrupt cliffs below the Castle mount. A beautiful and interesting section is there developed. The lowest bed, which is scarcely above the level of the stream, consists of a whitish sandstone and limestone forming a breccia; on this rests a stratum of reddish sandstone, forty feet thick, which is, in turn, capped by fourteen thin seams of soft ash-coloured limestone, interstratified with an equal number of others of greenish-gray slaty marl, mixed with sand and silvery mica; their aggregate thickness is twenty-five feet, which, with five feet of diluvium, will give seventy feet as the elevation of the escarpment. When viewed from below, the upper part of this singular cliff appears to be striped with the regularity of a ribbon. In the thick bed of sandstone, pear-shaped nodules of extremely hard white micaceous sandstone abound, and greatly impede the work of the quarry-men; some of these nodules are not many inches in diameter, but I measured one of two feet and a half; they are not ranged in lines, but their sharper extremities point towards the north-west, which is the full rise of the stratum containing them. Proceeding eastward to the vicinity of Horncliffe House, the rocks are still red sandstone, with similar calcareous seams as those near Norham resting upon them, and a cut, made to widen the road to the Chain Bridge, lays open thirty feet of rock, comprising six different strata; the lowest is red sandstone, the others limestone and slaty indurated marl. A slip of six feet cuts through these beds. Above West Ord, a cliff of sixty feet again exhibits the nature of the rocks; here the variegated sandstone rests upon the red, which is filled with nodules of red ochre, and is covered by the calcareous series so frequently mentioned; and at the plantations, a little lower down the river, six alternations of these thin beds are covered by thick strata of red and variegated sandstone. At Ord Mill, the red rock alone is visible; the dip of the whole series is southward of east. Diluvium now covers the rocks on the south of

shore of the Tweed the whole way to the harbour, but on the north bank, Berwick Castle stands upon an elevation about ninety feet high. Under the soil the rocks are variegated and red sandstones, of extremely fine-grained texture; the beds are thick, in which they may be compared to the *posts* in this part of our district, while the thin calcareous strata occupy the place of our *metals* and bituminous shales; but so considerable a proportion of carbonate of lime do all the sandstones hereabout contain, that they effervesce on the application of diluted mineral acids. The dip southward of east. From the rocks on which Berwick Castle is constructed to the entrance of the harbour the space is covered by soil; but both towards the north and south high and rugged cliffs bound the ocean. Those to the north shall first be brought under consideration. On passing through the Sally-port, and before reaching the Pier, the following succession of rocks rise to the day:—1st. A thick stratum of fine-grained brick-red micaceous sandstone. 2d. Hair-brown limestone, with small encrinites. 3rd. Slaty micaceous sandstone, of an ash-gray colour. 4th. Red sandstone. 5th. Encrinal limestone. 6th. White sandstone, blotched by red ochre and containing coal pipes. 7th. Encrinal limestone. 8th. Slaty micaceous sandstone. 9th. Encrinal limestone. 10th. Variegated sandstone. These strata occupy the space from the Sally-port to the Pier. The limestones are of inconsiderable thickness, and envelope bivalve shells as well as encrinites. The red and variegated sandstones are very fine grained, with but little mica; and the coal sandstones white, when not tinged by yellow ochre. At this point, which may be about a hundred yards north of the Pier, a slip dyke, of considerable magnitude, intersects the cliff, and may be traced eastward into the sea; its breadth is three yards, the south side of the chasm being filled for two yards by shale, and the north side by a rib of brownish-purple limestone, so hard as to give fire with steel; it is of a fine texture, with a splintery fracture, and impressions of the lanceolate leaves of some species of *Variolaria* of Ad. Brongniart, *Stigmaria* of Sternberg, are dispersed through it. The hade of the dyke is inconsiderable, but to the south of it the strata dip to the south-east at an angle of 45°. A little to the north, the rocks become less inclined, and dip to the east at a trifling angle; the upper is a stratum of ash-coloured shale, twelve feet thick, filled with Producti (*Productus scoticus*, Sowerby, Mineral Conch. t. 59, f. 3; and *Productus antiquatus*, t. 317, f. 1, 5, 6.), the shells of which retain their pearly lustre; the lower stratum is encrinal limestone, inclosing specimens of very large Producti (*Productus giganteus*,

teus, Sowerby's Mineral Conch. t. 320.)— being the same fossil which gives the name of cockle-shell limestone to one of the beds in the neighbourhood of Alston. On the beach the limestone is laid bare by the action of the waves, and exhibits the extraordinary undulations long since noticed in the stratification at Holy Island. Probably the stratum may be the same; but it is not safe to hazard conjectures on the identity of mineral beds on a coast where their dips are so various, and positions unconformable.

On the south side of the harbour, at the distance of half a mile from the bridge, the strata incline to the south-east at an angle of 45°, and are arranged in the following order:—1st, fine-grained pale red sandstone; 2nd, a thin stratum of slaty micaceous sandstone; 3rd, twenty-five feet of dark red micaceous sandstone; 4th, shale, with thin strata of encrinal limestone; 5th, red sandstone, divided by the same limstone:— the total thickness of these beds is one hundred and twenty feet. Below Spital Mill, half a mile further south, a thick stratum of sandstone, of peculiar appearance, crops out; it is yellow, blotched with red, and is very friable, its grains scarcely adhering; and on the beach, about twenty yards north of this spot, the limestone is separated by a parting of ash-coloured shale, containing bivalve shells (*Corbula limosa*, Fleming's British Animals, 426.) in abundance. Near Spital Farm, a dark gray compact limestone, containing vegetable exuviæ, similar to those noticed in the limestone in the dyke on the north side of the harbour, rises to the day about high-water mark, and may be considered another of the anomalous rocks of this coast. At the foot of the rail-road, situated a little further south, coal sandstone, inclosing casts of large vegetables, (*Stigmaria ficoides*, Sternberg, t. 12. f. 1, 2, 3; and *Lepidodendron obovatum*, t. 6. f. 1.) and bituminous shale alternate, beyond which a quarry has been worked in the red rock to the depth of forty feet. The stone it affords is hard and fine-grained, and has been used in constructing the new pier. Proceeding southward to Huds-head, the red rock, of which the cliff here consists, abuts against the coal sandstone, which is close behind it, and within two hundred yards one of the Scremerstone shafts is sunk. At North Scremerstone, two miles from Berwick Bridge, the rocks are red sandstone, shale, and encrinal limestone, the latter of which has formerly been quarried, and a little to the south, an extensive quarry is now open at a place called the Red Houses. The stratum is 18 feet thick, and affords a blueish-gray stone, close in its texture, and containing encrinites. It dips at an angle of 45°, and undulates in the same way as the limestone upon the beach

beach on the north side the harbour. Proceeding inland to Sunnyside Hill, where workmen are now employed in widening the great south road to Berwick, two excavations are made in the solid strata. At the northern cut, which is now twenty-two feet deep, the lowest rock is dark-gray encrinal limestone, covered by beds of coal measures of inconsiderable thickness, but interstratified with four thin seams of coal. The southern cut, which is nearer the summit of the hill, is at present fourteen feet deep, the lowest rock is a thin limestone bed; 2nd, a thin seam of coal with a band of shale; 3rd, limestone; 4th, coal and shale; 5th, red sandstone; 6th, coal and shale. The dip is, as usual in this vicinity, to the east. Sunnyside Hill is a mile south of Berwick. Near the coast, I observed no basalt *in situ*, and the only well-defined dyke of that description met with, was at Ousenton Bourn, a mile and a half east of Cornhill; the rib of basalt is 18 feet wide, and crosses the bourn from west to east. The blocks lie in a horizontal position, and the stone is dark-gray, approaching to black, with large greenish crystals of glassy felspar.

[To be continued.]

V. *An Examination of those Phænomena of Geology, which seem to bear most directly on theoretical Speculations*. By the Rev.* W. D. Conybeare, *M.A. F.R.S. F.G.S. &c.*

[In Continuation from vol. viii. p. 406.]

Observations on Article V. "The decreasing violence of the Convulsions affecting the Strata at successive Geological Periods."

WE have already noticed the effects of the dislocating forces which must have acted during the deposition of the strata referred to the Transition and Carboniferous formations, and we have found that the agency of these forces must have been universal and extreme during the first, and very general and very violent during the second period: in proceeding, we shall find that they are comparatively rare and partial in the formations of later origin, although they have never entirely ceased; and we are led by a strict analogy to ascribe the actual volcanic phænomena to the same causes, though at present acting with an energy greatly diminished.

Next to the carboniferous strata occur those of the magnesian lime, new red sandstone and lias: these as well as the succeeding oolitic formations remain very generally undisturbed, and in a position so little inclined that they have been thence denominated by many geologists on the continent as

* Communicated by the Author.

 well

well as in England, horizontal: throughout Germany and France such is their general situation, excepting in the vicinity of the great, though local disturbances which have elevated the Alpine and Pyrenean chains.

Partial disturbances are however yet observable. In the lias of Bristol, instances of faults of about 200 feet sometimes extending for more than a mile, and attended with contorted strata, &c. have been noticed in my paper on the South-west coal fields, in the Geological Transactions. The view of East cliff in the same memoir presents some smaller faults;—in my present neighbourhood, on the Glamorganshire coast, the lias which reposing on new red sandstone crowns the summit of Penarth Point, is towards the centre of that headland depressed about 100 feet to the sea level by a complicated fault. On the north of Barry Island is a fault which must be nearly 200 feet, throwing down the lias, and producing at the fracture curved and vertical strata. This fault strikes the contiguous shores of the mainland, and extends over an interval of a mile. Many other faults occur in the lias of this coast, which yet strikingly exhibits the decreasing energy of the convulsive forces in this as compared with the preceding period; for the carboniferous limestone is often exhibited towards the base of the cliffs, (its strata elevated 70 degrees,) on which the red marl and lias repose horizontally;—disturbances in the lias of the Yorkshire coast are mentioned in the surveys of Young and Phillips: and the analogous formations of Scotland, in the Brora coal-field, &c. are much deranged: indeed, from their relation to the adjacent primitive mountains it appears probable that the elevation of the latter was in part, at least, effected during this period.

The oolitic formations have been less examined in this respect. I may however mention, that in the neighbourhood of Bath I have found in the hills above Bitton, the inferior oolite to participate in a fault affecting the lias, and throwing the beds down about 200 feet. In the cliffs west of Bridport harbour on the Dorsetshire coast, a considerable fault accompanied with vertical strata may be observed. The disturbances affecting the oolites of the Weymouth district and Isle of Purbeck, must however be referred to the great convulsion which has affected the whole of that part of our coast and the Isle of Wight, subsequently to the deposition of the chalk formation, and during the tertiary period. The analogous formations of the Jura chain are much disturbed, the whole chain exhibiting in places an arched section; but these convulsions must be referred to the forces which have elevated the Alps, and which certainly continued their action until the

the middle of the tertiary period. The observations as yet made on that great chain are scarcely sufficiently full or accurate to determine whether that elevation was at once effected by a single period of convulsion, or gradually during many such successive periods *; but the latter opinion appears far more probable, and seems most agreeable with what is hitherto known. It is scarcely necessary to add, after our introductory observations on this article, that the method of determining this point would be, carefully to examine the junction of the different constituent formations, and carefully to examine how far they were conformably affected by the same convulsions. On this point the sections published by Ebel are scarcely sufficiently minute or accurate to afford the requisite information. In those of Mr. Murchison we find the tertiary conglomerates, &c. of Gossau overlying unconformably: but as on the Italian side the vertical beds of scaglia (equivalent to chalk) and of the succeeding tertiary deposits seem quite conformable to the older formations, we have here convulsions even as late as the tertiary period, compared with which, every thing of actual occurrence, the elevation of Jorullo, &c. dwindles into insignificance.

In our own island the elevation of the central range of chalk in the Isle of Wight, and that of the Isle of Purbeck, must be referred to the same period. If by examining the relations of the contiguous formations it appears to have been the result of a single convulsion, limited to a period subsequent to the lower tertiary deposits and antecedent to the higher,—this single convulsion, thus limited to a point of time geologically, affects a district nearly sixty miles in length (from the east of the Isle of Wight to Whitenore Point, east of Weymouth): and if we take into account the thickness of the strata moved, and the extent of their dislocation, it must have occasioned an angular movement throughout the whole of this space averaging more than 1000 feet. I could only desire the advocates of "actual causes," energizing with their present degree of power, to show me a single instance of any effect produced by them in the least comparable with this.

VI. The analogous rocks belonging to the different successive formations present a regular gradation in texture and consolidation: the earliest being the most crystalline and compact; and these characters becoming regularly less and less in the successive deposits, as they are more and more re-

* Elie de Beaumont, in his very valuable memoir "*Epochs de Soulèvement*," shows the Alps south of Savoy to have been elevated at an old tertiary period, the eastern Alps at a much newer.

cent.

cent. We also find that effects analogous to those which characterize the earlier rocks may be produced by igneous action.

Observations.—All rocks may be conveniently classed under the comprehensive genera Calcareous, Quartzose, and Argillaceous. We may examine what have been called the formation suites of each of these in order.—I. The Calcareous class presents, 1st, in the earliest deposits saccharine marble; 2ndly, compact and semi-crystalline rocks in the transition and carboniferous series; 3rdly, rocks of less compact and looser texture in the oolites; 4thly, earthy rocks in the chalk and tertiary formations.—II. The Quartzose series exhibits, 1st, crystalline quartz rock; 2ndly, compact sandstones in the carboniferous formation; 3rdly, looser sandstone; 4thly, sand. —III. The Argillaceous series is represented, 1st, by compact clay slate in the lowest deposits; 2ndly, by semi-indurated shales in the carboniferous group; and 3rdly, by common clay in the subsequent formations.

Now these changes are analogous to those which are known, or generally believed to be the result of igneous action. In Sir J. Hall's experiments on the fusion of lime under the pressure of a column of water, crystalline marble was produced: and besides these actual experiments we may refer to the changes effected by trap dykes, as universally acknowledged to be of igneous origin. In the north of Ireland the chalk where covered by trap becomes a compact limestone, and where intersected by trap dykes, assumes completely the texture of primitive saccharine marble for some yards from the contact. The lias shales become here and in Scotland altered by the contact with trap into flinty slates, and loose sandstones into compact and crystalline. In Professor Henslow's very valuable account of Anglesea, in the Cambridge Philosophical Transactions, much information on this subject will be found. In one place he describes a mass of granitic texture which appears to have resulted from sandstone thus altered. In Cornwall and the Lead Hills of Scotland, wherever the granite protrudes through the incumbent grauwacké, we find an intervening zone approximating in its characters to gneiss, which certainly appears to be grauwacké altered by the contact: and Boué believes this to be the case generally with the gneiss and mica slate of the Pyrenees.

The Alps appear at first sight to present an exception to the general rule announced at the head of this article; but it is in truth an exception of that kind which proves the rule. Here the limestones contemporaneous with our oolites still preserve a highly compact and crystalline character. This is well described

scribed in Professor Sedgwick's paper in your Number for August last; but if the elevation of these mountains be referred to a volcanic force which must have violently affected these regions to a later period than the general surface of our continents,—it is exactly what we should expect, that the constituent rocks should there also exhibit to a later period the effects of intense igneous action.

On the whole, then, as in our preceding article we saw reason to conclude, from the dislocations of the strata, that the forces (probably of a volcanic nature) which at first affected them with intense violence, subsequently from time to time experienced a gradual diminution of energy,— so we here find the texture of the constituent rocks indicating a like diminution of igneous action at the successive periods marked by the deposition of the series of formations.

VII. The series of organic remains both vegetable and animal included in the successive formations indicate also, a diminution of temperature from the earlier to the later periods.

Observations.—Adolphe de Brongniart's admirable treatise on vegetable fossils, fully proves this as to that kingdom. In a late communication to the Edinburgh Philosophical Journal, I have endeavoured myself shortly to state the argument as it affects the animal kingdom. Mr. Lyell has given a very ingenious explanation of the change of temperature as arising from the gradual growth of the continents and elevation of the mountain chains. I only doubt whether the cause thus suggested, is fully adequate to account for the degree of the resulting effects: besides which, the general analogy of the phænomena noticed in the preceding articles, all converging on one point, seems rather to indicate the gradual refrigeration of the surface of an originally heated mass, (such as the theories of Leibnitz and all his imitators suppose,) and this refrigeration must necessarily have accompanied the gradual formation of a solid crust.

[To be continued.]

VI. *On the New Nautical Almanac.*

IT is well known to most of our readers that, for many years past, numerous complaints have repeatedly been made against the state of the Nautical Almanac, as not keeping pace with the progress of astronomy and navigation: and the pages of our journal have from time to time contained many remonstrances and comments on this subject, from various individuals.

duals. An attempt, indeed, was made about seven years ago to redress the evil, and a Committee of the Royal Society was appointed to consider "whether any and what additions ought to be made to the Nautical Almanac." The result however was not attended with any advantage to science, as the only Resolution which they came to, was the following; viz. "that it would highly conduce to the interests of practical astronomy, if tables of precession, aberration, solar nutation and proper motion of 60 principal stars were formed *for every day, in the period of four years, including leap-year:* and that a separate table be given for every degree of the moon's node." And in consequence of this resolution, a folio volume of tables for that purpose was computed and printed at a great expense, which has been complained of as a manifest waste of public money; since no Observatory, except that of Greenwich, would, in the present state of science, ever think of resorting to so cumbrous a mode of assistance, amidst the numerous helps that are afforded by more accurate and elegant tables.

Seeing therefore no chance of improvement from this quarter, it was proposed to bring the subject before Parliament; and various papers were moved for and printed by the House of Commons, with this view: but, from an assurance that Government was about to take up the subject, the matter was then dropped. During the last summer, however, the Board of Admiralty (with whom the management of the Nautical Almanac now rests, by virtue of a recent act of Parliament) sent an official communication to the Astronomical Society of London, requesting their opinion and advice, as to the alterations and additions that it would be proper to make in that national work; and it is to the result of the Society's labours that we now wish to draw the attention of our readers.

The Council commenced their operations by nominating a Committee, consisting of 40 members, comprising not only some of the most profound mathematicians, but also most of the experienced practical astronomers and nautical men of science in the country, as well as the Professors from the naval establishments at Greenwich and Portsmouth. This Committee, having met, proceeded to examine and discuss *seriatim* the various parts into which the Nautical Almanac is divided; and having agreed on certain preliminary arrangements, appointed a Sub-Committee to examine them more in detail, as well as to examine and digest the various hints and suggestions which had been forwarded to them, not only by members of their own body, who were unable to attend the meetings, but likewise by other correspondents relative to this subject. The Sub-Committee

Committee having made a report of their labours, it was ordered to be printed; and a copy of the same (together with a *specimen* of the printed pages of the new almanac) having been forwarded to each member of the Committee, a *distant* day was appointed for taking it into consideration; by which means every opportunity and facility have been afforded for the most ample and open discussion of the several points in question. The final result of their deliberations is contained in a Report, which has been forwarded to the Admiralty: and we have the satisfaction of stating that nearly the last act of the late Board, was the approval of that Report, and the issuing of an order for its being carried into immediate execution.

We have been favoured with a sight of that Report (which will form a portion of the ensuing volume of the Memoirs of the Astronomical Society), and we here present our readers with the following summary of the principal alterations and additions.

The use of *apparent time* is abolished in all the computations: and *mean time* alone adopted.

The calculations are, in general, carried one place further in the decimals than has hitherto been done: that is, all quantities expressed *in time* are carried to *two* places of decimals in the seconds; and those *in space*, to *one* place.

The moon's right ascension and declination are given to *every hour;* and to the declinations are annexed the differences for every five minutes.

The places of the six principal planets are to be given for *every day;* and those of the four new planets for *every fourth day:* with an ephemeris of the latter for *every day*, for one month before and after their opposition.

The co-efficients A, B, C, D, which are used for computing the apparent places of the stars, are to be given for *every day.*

The apparent *contacts* of Jupiter's satellites, and also of their shadows, with the planet, are to be inserted.

The lunar distances of the *planets* are also to be inserted: with the *proportional logarithm* of the first difference annexed to *all* the lunar distances.

Predicted occultations (visible at Greenwich) of planets and fixed stars, to the *sixth* magnitude inclusive, are to be given: and also,

Elements for predicting such occultations of the planets and fixed stars, to the *fifth* magnitude inclusive, as may be visible in any habitable part of the globe: with the limits of latitude annexed, within which they will be visible.

The apparent places of the fixed stars are to be increased

 to

to 100 in number: α and δ *Ursæ Minoris* are to be given for *every day*; and the remainder for every tenth day as usual, but with the differences annexed.

The list of moon-culminating stars is to be incorporated with the work: and various tables added for facilitating the computations connected with this interesting and useful branch of practical astronomy.

These are a *few* only of the numerous alterations and additions that have been made to this national work. To enumerate the *whole* of them would far exceed the limits which we can conveniently devote to the subject; and we must therefore refer the reader to the Report itself. They are of a nature, as the Council very justly observe, to satisfy not only the wishes of the astronomer, but also the demands of the navigator; and (what is also very gratifying to hear) are not likely, with a due regard to œconomy, to add much to the expense of the publication.

Upon the whole we cannot help congratulating the public upon this vast accession of strength to the most useful branches of astronomy and navigation: and we consider that they are much indebted to the Council of the Astronomical Society, for the great labour and time which they have devoted to this important subject. It appears that an interval of two or three years must necessarily elapse before these improvements can be completely carried into effect. The Nautical Almanac for 1833 is already computed, and nearly ready for publication; so that the proposed alterations cannot take place till the year 1834: and the Council have particularly requested that they be not deferred beyond that period.

With a view of insuring a greater degree of accuracy in the computations, and as a means of detecting any errors, the Council have recommended that, in the Preface to each year's almanac, there be inserted an account of all the *tables* and *authorities* depended upon in every computation, with an express notice of such *equations* as may be omitted, or of any *corrections* introduced. And they have also recommended that notice of any errors should be advertised in the *London Gazette*, and in some of the public papers, as soon as possible after their discovery.

If these suggestions are strictly attended to, and the wholesome advice given by the Council be duly followed, we have no doubt that the important and valuable contents of the *New Nautical Almanac* will insure it a place in almost every vessel that sails on the ocean, and in every active observatory in the world.

VII. *On*

VII. *On the Visitation of Greenwich Observatory: with a Copy of the New Warrant.*

THE annual visitation of the Royal Observatory at Greenwich has, for nearly 150 years, been confided to the Council of the Royal Society and to such other persons as they might from time to time invite for that purpose, by virtue of the King's warrant directed to them at the commencement of every reign. His present Majesty, however, has been pleased to make a totally new arrangement on this subject. But, before we enter on the cause of this alteration, we would remark that when this annual visitation was first established, Flamsteed was greatly offended; inasmuch as he considered that the Council of the Royal Society (with whom he was not on the best terms) was thus set over him as a sort of spy upon his actions. It has however been silently acquiesced in by his successors; but, whatever importance it might at a more early period have possessed, it has gradually declined from its original object, and ceased to answer the purpose for which it was designed; for little or no business was done at the meeting: and if any matter requiring consideration was brought forward, it was always turned over to the Council of the Royal Society, where it was usually lost sight of, and altogether forgotten or neglected.

A representation of these circumstances was made in the proper quarter; and His present Majesty has been pleased to appoint a new set of *Visitors;* and has at the same time enlarged the powers hitherto granted to that body. By this warrant (which is dated last month) the President of the *Royal Society*, and five individuals nominated by him, together with the President of the *Astronomical Society*, and five individuals nominated by him, added to the Savilian Professor of Astronomy at Oxford, and the Plumian Professor of Astronomy at Cambridge, are now appointed the regular and permanent Visitors of the Royal Observatory. As many of our readers may be desirous of perusing this scientific document, we here insert it *verbatim*.

"William R.

"Trusty and well-beloved, we greet you well. Whereas, our Royal predecessor King George the Fourth did by warrant under his Royal sign manual, bearing date the nineteenth day of May, in the first year of his reign, constitute and appoint the President, and in his absence the Vice-President, of the Royal Society for the time being, together with such others as the Council of the said Royal Society should from time to time think fit, to be regular Visitors of the Royal Observatory

servatory at Greenwich, during His said Majesty's pleasure. Now know ye, that we have revoked and determined, and do by these presents revoke and determine, the said appointment, and every clause, article and thing therein contained. And further know ye, that we having been given to understand that it would contribute very much to the improvement of astronomy and navigation if we should appoint regular Visitors of our Royal Observatory at Greenwich with sufficient powers for the due execution of that trust, we have therefore thought fit, in consideration of the great learning, experience, and other necessary qualifications of our Royal Society and of the Astronomical Society, to constitute and appoint, as we do by these presents constitute and appoint, you the President for the time being of our Royal Society, together with our trusty and well-beloved John W. Lubbock, Esq.; Captain Henry Kater; George Peacock, Clerk; William Pearson, Clerk, Doctor in Divinity; and Richard Sheepshanks, Clerk, Fellows thereof: and you the President of the said Astronomical Society, together with our trusty and well-beloved Charles Babbage, Esq.; Francis Baily, Esq.; Captain Francis Beaufort; Doctor Olinthus Gregory; and J. F. W. Herschel, Esq., Members thereof; and likewise the Savilian Professor of Astronomy at Oxford, and the Plumian Professor of Astronomy at Cambridge, for the time being, to be regular Visitors of our Royal Observatory at Greenwich during our pleasure; authorizing and requiring you from time to time to order and direct our said astronomer and keeper of our said Royal Observatory to make such astronomical observations as you in your judgement shall think proper: and that you do survey and inspect our instruments in our said Observatory; and as often as any of them shall be found defective, that you do inform our Lord High Admiral (or the Commissioners for executing the office of Lord High Admiral), that so the said instruments may either be exchanged or repaired: and that you do from time to time make such suggestions and representations to our Lord High Admiral (or to the Commissioners for executing the office of Lord High Admiral), touching the said Observatory, the library, the instruments, and the observations, as in your judgement will be conducive to the credit of our Observatory, and to the promotion of astronomical and nautical science. And our further will and pleasure is, that our astronomer and keeper of the said Observatory for the time being, do deliver to you every three months a true and fair copy of all the observations he shall have made, and that such number of copies of the said observations be printed as the Lord High Admiral (or the Commissioners for executing the office of Lord High

Admiral)

Admiral) shall consider expedient. And when our said astronomer and the Council of our Royal Society and of the Astronomical Society shall have been supplied with as many copies as they may desire, to distribute for the benefit of science, the remainder shall be sold at such price as the Lord High Admiral shall fix. And our further will and pleasure is, that you do meet annually at our said Observatory on the first Saturday in the month of June, and at such other times as may seem expedient to our Lord High Admiral (or the Commissioners for executing the office of Lord High Admiral), and that at such meeting the President of our Royal Society shall take the chair, or in his absence the President of the Astronomical Society; or in the absence of both the said Presidents, that the Fellows and Members present (of whom seven shall form a quorum) shall elect a chairman for the time being among themselves: and that at every such meeting the chairman shall be empowered to call in and employ one of the assistants in our said Observatory to act as secretary for the time being. And our further will and pleasure is, that as often as any vacancies occur by death or resignation, the same shall be filled up by the President of the Society, in whose list such vacancy may have happened. And our further will and pleasure is, that any President of our said Royal Society, or any President of the Astronomical Society, who may have become a Visitor to our Royal Observatory, by virtue of his office, shall during our pleasure continue to be a Visitor notwithstanding that he may have vacated the office of President of such Society. And for so doing, this shall be your warrant. And so we bid you farewell.—Given at our Court at Saint James's, &c. &c. &c.

"To our trusty and well-beloved the President of our Royal Society for the time being, the President of the Astronomical Society for the time being, and the other persons hereby appointed Visitors of our Royal Observatory at Greenwich.

By His Majesty's command,

"ROBERT PEEL."

VIII. *Examination of a Native Sulphuret of Bismuth.* By *Mr.* R. WARRINGTON*.

THE mineral which forms the subject of the present paper, is found in the western parts of Cornwall; it occupies the cavities and fissures of a porous mass of yellow copper pyrites and silica, in the form of striated needles and bands.

* Communicated by the Author.

It

It has exteriorly an iron-gray colour, sometimes with a bismuthic tinge, and in its cleavage surface possesses a lustre approaching that of polished steel. Its specific gravity is 5·85, and its hardness = 2·7. When heated before the blowpipe on charcoal it inflames, and by increasing the heat for some time, appears to be entirely volatilized, with the exception of a minute globule of brown scoriaceous matter.

On examination it was found to contain bismuth, sulphur, copper, iron, and siliceous matter. The first analysis was performed by acting upon the mineral, reduced to a very fine powder, with nitro-muriatic acid, until the whole of the sulphur was acidified; this was conducted in a small stoppered retort, to which a receiver was attached, in order to collect any small quantity of sulphur that might be carried over mechanically during the digestion. The solution thus obtained was diluted with water, and filtered to separate the silica; a solution of nitrate of baryta was employed for the precipitation of the sulphuric acid, and the sulphate of baryta (and also the silica) washed at intervals with warm dilute nitric acid, to remove any small quantity of bismuth which might fall by the gradual dilutions.—After the separation of the excess of baryta, ammonia was added in slight excess, which threw down the oxides of bismuth and iron, and held the oxide of copper in solution; by evaporation to dryness and the addition of potassa this oxide was obtained.

The mixed oxides were then acted upon by dilute muriatic acid, added in small quantity; the oxide of iron was thus completely removed, and the dichloride of bismuth which remained, after being digested in a weak solution of potassa, was collected as an oxide: the iron was again precipitated from its muriatic solution by ammonia.

Although this analysis was conducted with the greatest care, and repeated in order to avoid ambiguity, yet the results in both cases exceeded the weight of the mineral employed. Upon heating the oxide of bismuth obtained in the second analysis, before weighing (and which was performed in a small tube of green glass sealed at one of its extremities), it was observed that a small quantity of white opaque vapour arose and appeared to be condensed upon the upper part of the tube, and on adding distilled water to it, a precipitate of dichloride of bismuth was instantly formed, proving it to have been sublimed chloride of that metal. The oxide itself was next examined; by dissolving it in pure nitric acid, and testing the solution with nitrate of silver, a small quantity of chloride of silver was thrown down.

Having ascertained these facts, a solution of muriate of bismuth

bismuth was prepared, and the three following experiments tried with it:—one quantity was precipitated by potassa in great excess, another by ammonia, and these were digested at a boiling heat for about six hours; the third portion was added gradually to a large quantity of very hot solution of potassa; and the whole three collected and well washed, dissolved in nitric acid and tested as before; muriatic acid was however detected in each. It was evident from these results, that muriatic acid could not be employed in the analysis, or that, if employed, it must be separated before the precipitation of the oxide of bismuth. 6·88 grs. of the mineral were digested in nitric acid as long as any sulphur remained undissolved; it was then filtered, and gave ·345 gr. silica. The sulphuric acid was next separated by a solution of nitrate of baryta added as long as any precipitate was occasioned, and the sulphate of baryta, after heating to redness, weighed 9·654 grs. After the excess of baryta had been carefully removed, ammonia added in excess threw down the oxides of bismuth and iron as before, and held the oxide of copper, which was obtained in the manner before stated, and equalled ·306 of a grain. The weight of the mixed oxides was 5·594 grs., which were then dissolved in muriatic acid, and a current of sulphuretted hydrogen passed through the solution, and the whole thrown upon a filter: the clear solution which passed through was boiled for some time, and after the addition of a little nitric acid to bring the iron to the state of peroxide, ammonia was added, and the oxide collected weighed ·344 gr.; deducting this from the weight of the mixed oxides, leaves 5·25 grs. as the quantity of oxide of bismuth; the results are, therefore,

Oxide of bismuth......	5·25	=	4·718 bismuth.
Sulphate of baryta	9·654	=	1·309 sulphur.
Peroxide of iron.......	·344	=	·241 iron.
Peroxide of copper...	·306	=	·245 copper.
			·345 silica.
			6·858
			·022 loss.
			6·880

Or, we may consider the mineral to be constituted of 5·7815 grs. sulphuret of bismuth, being in the proportion of 1 atom bismuth + 1 atom sulphur, and that the iron, copper, and silica are merely parts of the matrix which cannot be separated mechanically from the pure mineral.

IX. *Re-*

IX. *Recent Discovery of the Ladder of* M. de Saussure *in the Mer de Glace; with Inferences respecting the Progressive Movement of Glaciers.*

[We have been favoured with the following paragraph from the *Journal de Genève,* to which are added a few observations by an English gentleman resident in that town.—Edit.]

"THE ladder which M. de Saussure used in crossing the crevices in the ice during his first visit to the Col du Géant, and which he left on the upper part of the glacier, has lately been discovered imbedded in the Mer de Glace, in a situation nearly opposite to the aiguille called *Le Moine.* This ladder, moving on with the body of the ice, will thus appear to have advanced three leagues since the year 1787."

M. Plouquet, a German writer, published some years since a pamphlet in which he endeavoured to prove that the progressive movement of the glaciers was a thing physically impossible. If M. Plouquet, or the editor of the Literary Gazette of Jena, in which paper appeared a confirmation of his statement, could visit the spot where the immortal De Saussure's ladder now is, and still persist in the opinion that the progressive movement of the glaciers is a thing physically impossible, we think we should be able to combat that opinion by the following observations, and by the experiment which has been renewed at the instigation of Captain Sherwill at the Mer de Glace, as stated by that gentleman in his "Ascent of Mont Blanc."

There are in the neighbourhood of Mont Blanc and elsewhere, many glaciers which terminate at the edge of a precipice, where may be seen walls of ice from one to two hundred feet perpendicularly high. From these walls immense blocks of ice detach themselves frequently in the course of a day and fall over the precipice, separating in their course, and thus dissolve according to the season of the year.

Who then will doubt that the ice is continually projected forward from the upper to the lower part of the glacier, and that the main body thus pushing on causes the fall of these masses over the frightful precipice.—But let us take another proof: the blocks of granite and other large stones seen riding on the surface of the glaciers, and which in the end arrive in the valleys that receive the waters of these eternal reservoirs,—how comes it that these granite blocks descend from an elevation of ten or fifteen thousand feet, if it were not that the body on which they are placed was in continual, though to the eye imperceptible motion? These facts would rather prove that the *quiescent state* of the glaciers would be a thing physically impossible.

Captain

Captain Sherwill in his relation of his ascent of Mont Blanc, speaking of the glaciers, says, "In traversing these stagnated oceans, very large blocks of granite of many tons weight may be seen riding on the surface of the ice. These blocks have afforded the means of ascertaining a fact of importance. The experiment I am about to relate to you was made last year by some of the guides of Chamouni. Two poles were erected, one on each side of the glacier, out of reach of its movement, and so placed as to be in a direct line with a block of granite. In the course of twelve months this block had entirely changed its position as respecting the two poles, and had advanced about one hundred yards on its march towards the valley;—a clear proof that the glaciers do move on, and are continually diminishing at their lower extremity by the melting of the ice, and increasing at the upper end by the constant snows."

We do not therefore believe that there is a single inhabitant of the valleys into which the glaciers descend, who entertains the smallest doubt of their progressive movement: and we will venture to say, that the "physical impossibility" raised and stated by the learned German, arises from a superficial examination only of the glaciers, in which the generative and destructive forces of nature are so happily combined, that no fear need be entertained of the too rapid progress of them towards the fertile and pastoral valleys which for centuries past have been *threatened*, but nothing more.

If the progress made by the ladder of M. de Saussure, taken for one year, and the result of the experiment made at the instigation of Captain Sherwill, should not appear to agree, it must be recollected that from the Col du Géant, to the spot where the ladder is at present, is a very rapid descent, and of course the march of the glacier would be rapid in proportion: whereas the experiment of Captain Sherwill was made on a level part of the same glacier, the Mer de Glace, where the ice is of a more compact texture than that at an elevation of above ten thousand feet, and consequently its progress towards its final issue would be somewhat slower.

X. *Facts and Observations relating to the Theory of the progressive Development of Organic Life.* By Robert Bakewell, *Esq.**

As it will be readily conceded that the true object of all geological investigations should be the discovery of truth, and not the support of hypotheses, the following account may

* Communicated by the Author.

deserve attention, in reference to certain opinions that have been recently advanced in geology; and it may serve to prove how extremely cautious we should be in drawing general inductions from isolated facts. During a visit to Nottingham in the last summer, a medical gentleman in that town brought me part of a bone which was pronounced by an eminent physiologist to be a portion of the femoral bone of a horse or an ox. This bone was found in forming an excavation in the sand-rock on which Nottingham and its Castle stand; it was about forty feet below the surface; and the workmen who found it asserted most confidently, that the rock in which it was imbedded was solid, and that there was no fissure or opening near the place. The sand-rock of Nottingham contains numerous rounded pebbles of quartz, quartz-rock, jasper, and Lydian stone, and occasionally pebbles of granite, slate, and porphyry: its first aspect presents the appearance of an alluvial or diluvial formation, and this resemblance is further increased by the soft incoherent state of some of the beds. It may however be proved to be a member of the new red sandstone; for some of the yellowish beds abounding with pebbles alternate with well characterized red sandstone; the whole may be seen passing under the red marl with gypsum, on the north and east side of Nottingham; and as this marl passes under the lias on the south, the true position of the Nottingham sand-rock in the series of British strata is most clearly established. As the occurrence of the remains of a *large* mammiferous quadruped, in a bed of such great relative antiquity, was a fact at variance with what had hitherto been known, I was persuaded there was some error in the statement, and particularly as I observed, where a section was making in the rock west of the town, there were many deep vertical fissures in it, filled with loose sand; this was the case also in other situations where the bare rock was exposed to view. To confirm or invalidate the truth of the workmen's assertion, the excavation was carefully examined with lights, and a break or fissure was discovered through which the bone was doubtless introduced, though the fissure was now closed with loose sand.

Thus this apparent geological anomaly was clearly explained, and many anomalous facts of a similar kind that have been described, would I doubt not admit of a solution equally satisfactory if the circumstances were accurately examined.

Mr. Lyell, in his very ingenious and elaborate "attempt to explain the former changes on the earth's surface by a reference to causes now in operation," has stated "that the occurrence of one individual of the higher classes of mammalia, whether

whether marine or terrestrial, in the ancient strata, is as fatal to the theory of successive development as if several hundreds had been discovered." Could we be certain that the individual had been really contemporaneous with the rock in which its remains were found, we might admit the truth of the induction; *but this certainty we can never obtain from the remains of one, or even of more than one individual imbedded in any rock whatever:*—for when we consider what fractures and convulsions have affected the ancient crust of the globe, and how much it has been torn by currents and inundations, we are compelled to admit that organic remains from the upper strata may sometimes be buried in the lower rocks. The real subject of surprise is, that such instances are not of more frequent occurrence. It is well known to practical men, that fractures in many of the strata are so completely closed by pressure or infiltration in a short time, as scarcely to leave a trace of their former existence:—what must be the case then when these causes have been in operation for thousands of years? It is stated in the same work, that "a single vertebral bone of a saurian animal, with a patella, and echinal spines, have been found in the mountain limestone of Northumberland." Supposing the fact to be correct, these organic remains being common in the oolitic strata, and never having been found before in the mountain limestone; if we are to introduce the law of chances into geology, we may say that the chances are many millions to one against their being found *together* as coexisting animals in a formation in which they have hitherto been absent: but it is extremely probable that they might have been transported together through a fracture into the strata below, and that this fracture has been subsequently closed; hence all inferences drawn from such anomalous facts are of little value. The entire skeleton of a man imbedded in solid coal 97 yards below the surface, at Ashbywolds in Leicestershire, which I mentioned in chap. i. of my "Introduction to Geology," proves how cautious we should be in drawing conclusions from individual instances. The men, when the skull was first discovered, ascended to inform the proprietor of the mine, and told him at the same time that the coal was solid and unbroken around it; but when he examined the place, as they were clearing out the remainder of the skeleton, he perceived that the coal, though apparently compact, was not so solid as in other parts of the bed; and by opening passages in different directions, the appearance of an ancient pit was discovered, though it had not been worked, nor was there any tradition in the neighbourhood of its having been sunk.

 A living

A living lizard was found in a bed of coal at Rothwell Haigh near Leeds, about twelve years since. I saw it soon after it was found, preserved in spirits: it was nearly seven inches long, and is now in the possession of the Rev. Dr. Sharp, vicar of Wakefield. The depth of the mine is one hundred and eighty yards; it has been worked many years; and being situated in elevated ground, has levels for drainage nearly as low as the river Calder, so that it is not very difficult to admit that the lizard might find a ready passage into the mine, and have sunk into a fissure in the coal, and remained there in a nearly torpid state till it was discovered in working the coal. Had the lizard died, and its bones become mineralized by water containing the sulphate and carbonate of iron, which abounds in the mine, we should have had an instance of a saurian animal in coal, which might have been cited to prove the high antiquity of a species of reptile similar to what is now living in the country. The experiments of the late Dr. Jenner, which I have mentioned elsewhere, prove that bones may be partially mineralized in a few months by immersion in lias mud, containing much metallic and saline matter. On the other interesting disquisitions in Mr. Lyell's work, it is not my intention to offer any remarks at this time; they cannot fail to render an important service to geology, by the searching investigations to which they will undoubtedly give rise: but I maintain that the theory of the progressive development of organic life cannot be overturned by individual anomalous exceptions, by ingenious reasoning, or by negative evidence*. It is true that this theory, which holds that a succession of more perfect classes and orders of animals may be traced, in ascending from the lower or more ancient strata, to the more recent formations, has been carried too far by some of its supporters; and like other general conclusions in every science, requires to be admitted with certain limitations: yet it appears to me, in the present state of our knowledge, to be one of the most interesting and best established doctrines in geology. Whenever several individuals belonging to different genera, in any of the higher orders of the class Mammalia, shall be discovered in the ancient strata, then indeed may we fairly admit that the theory of the progressive development of organic life is completely refuted.

I had intended to send some observations on certain parts of the geology of Nottinghamshire, Derbyshire, and Leicester-

* By negative evidence, is meant that which is grounded on our ignorance of the organic remains that may possibly exist in the ancient strata, in countries that have not yet been examined.

shire,

shire, which I have recently examined: but I must reserve the communication for a future Number of your Annals.

Hampstead, Dec. 14, 1830. ROBERT BAKEWELL.

P.S. I omitted to mention, that the bone found in the Nottingham sand-rock appeared partially mineralized, and much resembled bones from some of the tertiary beds.

XI. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Nov. 18, 1830.—A PAPER was read, entitled, "On the nature of negative and imaginary quantities." By Davies Gilbert, Esq. President of the Royal Society.

The object of this paper, the author shows, is one that has given rise to much controversy, and has been involved in much unnecessary mystery. Paradoxes and apparent solecisms, when involved with facts and indubitable truths, will always be found, upon accurate examination, to be near the surface, and to owe their existence either to ambiguities of expression, or to the unperceived adoption of some extraneous additions or limitations into the compound terms employed for definition, and which are subsequently taken as constituent parts of their essence.

The first misapprehension pointed out, is that of considering any quantity whatever as *negative per se*, and without reference to another opposed to it, which has previously been established as *positive*. In order to avoid previously formed associations of ideas, the author prefers employing in his reasonings on this subject, the symbols (a) and (b) to express this quality of opposition, rather than the usual ones of *plus* and *minus*.

By the aid of this notation he is enabled to present, in its full generalization, the law of the signs in multiplication,—a process which, it is well known, is founded solely upon the principle of ratios; and to show that like signs invariably give the sign belonging to the assumed unity, or universal antecedent of the ratios; and unlike signs, the contrary.

Since either the one or the other of the arithmetical scales derived from the two unities is in itself equally affirmative, but negative with relation to the other, it follows, that by using the scale of (b), all even roots in the scale of (a) will become imaginary, and thus the apparent discrimination of the two scales is removed; so that the properties belonging to the two scales are interchangeable, and all formulæ become universally applicable to both, by changing the signs according to the side in which the universal antecedent is taken. Imaginary quantities, then, are merely creations of arbitrary definitions, endowed with properties at the pleasure of him who defines them; and the whole dispute respecting their essence turns upon the very point that has been contested from the earliest times, between the hostile sects of realists and nominalists.

It

It is now, however, universally agreed, that all abstractions and generalizations are mere creatures of the reasoning faculty, existing nowhere but in the mind contemplating them. Such, in algebra, are the supposed even roots of a real quantity, taken in the scale opposite to that which has given the universal antecedent: the sign indicating the extraction impossible to be performed, veils the real quantity, and renders it of no actual value until the sign is taken away by an involution, the reverse of the supposed operation which the sign represents; although the quantity itself is, in the mean time, by its arbitrary essence, made applicable to all the purposes for which real quantities are used, in every kind of formula.

Several illustrations of these views of the nature of imaginary quantities occurring in logarithmic formulæ, and series expressing circular arcs, are given by the author. By considering all quantity as affirmative *per se,* and admitting *plus* and *minus* merely as connective terms, we thus succeed in banishing mystery and paradox from the science most powerful in eliciting truth, and where they ought least to find a place.

Nov. 25.—A paper was read, entitled, "On a simple electro-chemical method of ascertaining the presence of different metals; applied to detect minute quantities of metallic poisons." By Edmund Davy, Esq. F.R.S., M.R.I.A., and Professor of Chemistry to the Royal Dublin Society.

The Voltaic arrangement employed by the author consisted merely of small slips of different metals, generally zinc and platina, placed in contact and forming a galvanic circuit with the interposed fluid suspected to contain the poisonous metal; in which case, as was formerly shown by Sir H. Davy in his Bakerian lecture, the metal held in solution was deposited in the form of crystals, on the negative surface. The zinc was usually employed in the form of foil; the platina was, in some cases, a small crucible, or a spatula, but more frequently platina foil was used. It is generally necessary to mix a few drops of acid with the metallic compounds that are subjected to this test, and that are placed in contact with the platina: on applying the zinc foil, the platina will soon become coated with the reduced metal.

The author then enters into the detail of his experiments on the efficacy of his method in the detection of arsenic, mercury, lead and copper, in their different states of oxidation and saline combinations; and of the precautions necessary to be observed in the case of each metal. He was enabled to detect the presence of arsenic, by the exhibition of its characteristic properties, when only the 500dth part of a grain of that metal was deposited on the platina; and in some instances could appreciate even the 2500dth part of a grain, by the application of appropriate tests.

The author next ascertained that the electro-chemical method is competent to the detection of very minute quantities of the different metals, when their compounds are mixed with various vegetable and animal substances. Thus, the presence of arsenic would readily be discovered when mixed with all the ordinary articles of diet,

diet,—such as wheaten flour, bread, starch, rice, potatoes, peas, soup, sugar, vinegar, gruel, tea, milk, eggs, gelatine, and various kinds of wine; also when mixed with the principal secretions of the alimentary canal, as bile and saliva. Arsenious acid mixed with butter, lard and oils, or with sheep's blood, or ox bile, was detected with great ease. Similar results were afforded by corrosive sublimate, the acetate of lead, and sulphate of copper, added in small quantity to the most complicated mixtures of organic substances. In some instances where the common tests do not act at all, or only act fallaciously, the electro-chemical method acts with the greatest certainty.

Anniversary Meeting, Nov. 30th.—On this occasion the President, Davies Gilbert, Esq. M.P. delivered the following Address :

Having now, for the last time, to address you in reference to the loss of eminent persons sustained by the Society in the preceding year, I cannot but congratulate you on the difference between the list now read, and that which we had the misfortune to hear twelve months ago. Several individuals of great distinction, of extensive acquirements and of splendid talents, are undoubtedly brought before us on the present occasion : but advanced age or long absence from this metropolis tend in some instances to lessen the pain we should otherwise feel on the recital of their names. While in the former case, persons at the very head of different departments in science, of our own ages, and daily conversant with our social habits, were suddenly taken from us, leaving the higher paths of science (as we feared at the time) without a foot that might in future trace their windings ; and our more familiar society without that sparkling of intellect, which invigorates the understanding, and at once elevates and refines the common intercourses of life.

The individual, who unquestionably demands our first attention is Major James Rennell, taken from us in his eighty-eighth year, lamented by all those who are capable of appreciating his science, and by every one conversant with his active virtues or with the simplicity and kindness of his manners.

I have endeavoured to collect some particulars respecting this distinguished person in his early years.

Major Rennell was descended from an ancient and respectable family in Devonshire, said to be of Norman origin. His father was a Captain in the Royal Artillery, and fell at the siege of Maestrich. James Rennell was born at his father's house, Upcott near Chudleigh, in Devonshire, on the 23rd of December, 1742. He entered on the naval service of his country at a very early age, where his spirit and exertions soon attracted the notice of Sir Hyde Parker, with whom he sailed in the Brilliant frigate to India. After the conclusion of peace, his eager desire for active service induced him to quit the navy, and he obtained a commission in the corps of engineers belonging to the East India Company. His zeal and ability in discharging the duties belonging to this station obtained for him the friendship

friendship of many superior officers, and especially of the great Lord Clive; and he was soon promoted to the station of Surveyor General in Bengal.

The fatigues attached to this civil employment were sufficient to exhaust the strength of any European constitution, conducted as were the surveys, with indefatigable industry, along the banks of the great rivers, periodically overflown and perpetually damp. But these were not all: Major Rennell in encountering dangers which are inseparable from military renown, had suffered wounds so severe that he was, I believe, twice left exposed on the field of battle, and never recovered from their effects up to the latest period of his life. These altogether compelled his return to England, and alone prevented him from attaining the highest military stations.

Retired to private life, the whole energies of his mind were directto scientific and literary pursuits. We have, founded on his exertions in India: An Atlas of Bengal.—A Map of the Mogul Empire.—Marches of the Army in India.—A Map of the Peninsula.

But the mental powers of Major Rennell were far from being confined to one region of the world.

We have from his pen a work on the Geography of Africa. And with a vigour of intellect that may well call to our recollection the greatest of the Roman Censors, he acquired at an advanced age a competent knowledge of Greek for consulting the early writers in that language, and gave to the world, The Geographical System of Herodotus, including the Expedition of Darius Hystaspes to Scythia; The Site of Babylon; The Temple of Jupiter Ammon; The Periplus of Africa, &c.; and A Dissertation on the Locality of Troy.

The attention of this great investigator of every thing connected with the surface of our globe, extended itself from mountains and plains to the waters of the ocean; and produced a most curious investigation of the currents prevalent in the Atlantic, and of accumulations caused by certain winds in the English Channel.

And lastly, I would mention a very ingenious mode of ascertaining distances, and connecting with their bearings the actual localities of spots in the Great Desert, by noting the average rate at which camels travel over those worlds of sand.

This is a very imperfect catalogue of the works published by Major Rennell; and I am happy to add that several more exist in manuscript, destined, we may hope, at no distant time, to appear.

Major Rennell has been honoured by the Copley Medal from this Society; by the Gold Medal from the Royal Society of Literature; he was a Corresponding Member of the Institute of France; and a Member of various other Societies.

Our regret for such a man, exerting his intellectual powers with so much energy and to such useful purposes, throughout the course of a long life, and up to his eighty-eighth year, must always be strong and sincere; but we console ourselves with the reflection that he had attained the utmost ordinary limit of human life, amidst the respect and esteem of all who knew him, and that his memory is revered.

Mr.

Mr. Chenevix was undoubtedly a man of considerable ability, acquirement and industry. We have from him seven different communications to the Philosophical Transactions:

An analysis of the arseniates of copper.—Observations on Dr. James's powders, with a method of preparing a similar substance in the humid way.—Observations and experiments upon oxygenated and hyperoxygenated muriatic acid.—An analysis of corundum.—Observations on the chemical nature of the humours of the eye.—Inquiries concerning the nature of a metallic substance, under the title of Palladium.—On the action of platinum and mercury on each other.

In the latter years of his life, which could not have reached threescore, he appears to have abandoned chemistry, and to have fallen on speculations wholly unworthy of being noticed from this place.

The only remaining individual who has taken a direct active part in our labours, by contributing to the Transactions, is Mr. James Lewis Smithson, and of this gentleman I must be allowed to speak with affection. We were at Oxford together, of the same College, and our acquaintance continued tó the time of his decease.

Mr. Smithson, then called Mácie, and an undergraduate, had the reputation of excelling all other resident members of the University in the knowledge of chemistry. He was early honoured by an intimate acquaintance with Mr. Cavendish; he was admitted into the Royal Society, and soon after presented a paper on the very curious concretion frequently found in the hollow of bambû canes, named *Tabasheer*. This he found to consist almost entirely of silex, existing in a manner similar to what Davy long afterwards discovered in the epidermis of reeds and grasses.

Mr. Smithson enriched our Transactions with seven other communications:—A chemical analysis of some calamines.—Account of a discovery of native minium.—On the composition and crystallization of certain sulphurets from Huel Boys in Cornwall.—On the composition of zeolite.—On a substance procured from the elm-tree, called *Ulmine*.—On a saline substance from Mount Vesuvius.—Facts relative to the colouring matter of vegetables.

He was the friend of Dr. Wollaston, and at the same time his rival in the manipulation and analysis of small quantities. Αγαθη δ' ερις ἡδε βροτοισι. Mr. Smithson frequently repeated an occurrence with much pleasure and exultation, as exceeding any thing that could be brought into competition with it,—and this must apologize for my introducing what might otherwise be deemed an anecdote too light and trifling on such an occasion as the present.

Mr. Smithson declared, that happening to observe a tear gliding down a lady's cheek, he endeavoured to catch it on a crystal vessel: that one-half of the drop escaped, but having preserved the other half, he submitted it to reagents, and detected what was then called microcosmic salt, with muriate of soda; and, I think, three or four more saline substances; held in solution.

For many years past Mr. Smithson has resided abroad, principally, I believe, on account of his health: but he carried with him the

esteem and regard of various private friends, and of a still larger number of persons who appreciated and admired his acquirements.

Of gentlemen who have not taken a direct share in the labours o. this Society, I would notice Mr. Henry Browne.

No one, I believe, was ever more distinguished in the important station of commanding those vessels which secure to England the commerce of nations unknown to former ages; nor did any one more largely contribute towards introducing the modern refinements of nautical astronomy, which skilfully pursued, and under favourable circumstances determine the place of a ship with greater accuracy, than what in the early part of the last century would have been thought amply sufficient for headlands, roadsteads, or harbours of the first importance. And I cannot omit this opportunity of congratulating all those who addict themselves to astronomical pursuits, or who feel an interest in the perfection of geography and navigation, on the great improvements recently suggested and likely to be made in our national ephemeris; improvements which, in part at least, I hoped to have got adopted twelve years ago: but now under more fortunate auspices I flatter myself that they will be carried into execution, and their practical advantages cannot fail of being very great.

Retired to private life, Mr. Browne usefully amused his declining years by a continuance of his favourite pursuits; and up to the latest period of his life he patronised, encouraged, and promoted practical astronomy.

Lieutenant-Colonel Mackenzie has, I understand, cultivated science in the East, but no particulars have come to my knowledge.

Sir Lucas Pepys is well known to have attained considerable eminence in his profession.

The Rev. Stephen Weston will long be remembered for his learning, abilities, good nature, and for his eccentric compositions on various subjects, and in different languages. And for one at least, I may truly say, that it would gratify me to find a more permanent reputation secured for this excellent man, by a collection being given to the public of his numerous Opuscula.

The late Duke of Atholl demands also attention, not on account of his high station, but as a patron of science, and especially of that most important, interesting and rapidly improving branch of science, Geology.

Geology, deriving its birth from the continent of Europe, seems to have been drawn to this island by the genius of Dr. Hutton, and here to have grown with the vigour of youth under the fostering hands of many who now hear me, and also of a gentleman to whom the Duke of Atholl afforded every assistance to be derived from his large property, and his extensive influence.

The Duke of Atholl has also at once enriched and decorated his country; and afforded an instructive example to all other proprietors of similar wastes, by clothing tracts of land, incapable of a different cultivation, with the most valuable of the pines. His forests of larch, which have acquired maturity in the course of a single life, promise not merely to supersede the use of foreign deal, but to allow of our

reserving

reserving the tree always esteemed the peculiar pride and boast of this island, for the construction of ships of war on the largest scale.

Another individual remains, whom no technicality in regard to pursuits can prevent our noticing with honour, on this occasion: whose very deportment indicated the elegance of his mind; and the justness of whose remarks on every thing connected with art, gave assurance of the perfection invariably found to exist in all subjects created by the touch of his magic pencil.

Sir Thomas Lawrence stands proudly preeminent among native artists, and perhaps among artists of the whole world, in that department to which he exclusively applied the powers of his genius: nor would, I am persuaded, the great painter of the preceding age have been unwilling to admit him as his equal in the delineation of portraits—not the servile copies of individual features, but poetic likenesses, where every excellence is heightened, where the mind is depictured, and where the particular person seems to embody the class of virtues, of intellectual powers, or of amiable qualities designating the moral order in which he is arranged.

This constitutes unquestionably a department of historical painting, not inferior, perhaps, nor even less difficult of acquirement than the others, where all is imaginary.

The name of Reynolds must, and, for various reasons, ever will stand first on the list of those who have cultivated in this country the whole extent of an art, the most refined, requiring talents the most rare, and at the same time the most delightful of all that have sprung from the human mind;—but that of Lawrence will be hailed by the Academy as their *Spes altera,* and their *Decus gemellum.*

I am not aware of the loss of any Fellow of the Society on our Foreign List.

Gentlemen,

Your Council for the past year have awarded one of the Royal Medals to Dr. Brewster, for his various communications on Light, printed in the last volume of your Transactions.

Unable as we are to investigate the real essences of physical bodies, it is impossible nicely to discriminate their relative importance by observing the external or accidental properties they may assume: but light is so preeminent in all its relations; as the cause of vision; in the rapidity of its flight, or of its vibration; in its connection with heat; in its adorning every thing in nature by a secondary quality;—that no more could be wanting to secure its place at the head of that class of transcendant or imponderable substances, which appear to animate the material world.

Other properties have, however, been recently discovered, not less wonderful than those that were previously known, and which promise to decide the long agitated question between corpuscular projection and the vibration of a fluid at once inconceivably elastic and rare.

In all these discoveries Dr. Brewster has taken an ample share. And as a public testimony of the sense entertained by the Royal Society of their importance, and of his ability and exertions, I have the honour of presenting to him the Royal Medal.

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The discovery of any new elementary substance has ever been deemed an occurrence worthy of being marked by some public declaration of applause.

The ascertaining chlorine to be, in the actual state of our knowledge, one of this class, has justly been considered as among the most brilliant of Sir Humphry Davy's achievements in chemical science. Iodine has been added to the supporters of combustion, occupying, like oxygen and chlorine, the negative extremity of the scale in Electro-chemistry.

More recently another substance, apparently intermediate between chlorine and iodine, has been derived from the same source as that yielding the latter,—from the water of the sea; and from its peculiar odour denominated brome, and subsequently bromine. An ample account of the properties distinguishing this substance may be found in a memoir by the discoverer, Mons. Balard of Montpelier, read before the Academy of Sciences, published in the *Annales de Chimie*, vol. xxxii. p. 337, and abridged in the twenty-second volume of the Quarterly Journal of Science, p. 384.

It will be seen by referring to the Second Part of our Transactions for the present year, that Dr. Daubeny has detected bromine in various springs; and it appears that the action of this substance, on the living system, unites with its chemical qualities in associating it with iodine. So marked and so decisive indeed are its effects, that various medical waters are conjectured to owe their beneficial qualities to the presence, in extremely minute portions, of this elementary body, unknown and unsuspected previously to the researches of M. Balard.

To him, therefore, I am directed by your Council to deliver the other Royal Medal, in testimony of the high respect entertained for his ability, industry, and skill displayed in the discovery of bromine.

The Copley and the Rumford Medals have not been awarded.

The Society next proceeded to the election of the Council and Officers for the ensuing year, when the following were declared to be the lists:—

Council.—Peter Barlow, Esq.; John Barlow, Esq.; William Cavendish, Esq.; Sir Astley Cooper, Bart.; Henry Ellis, Esq.: Michael Faraday, Esq.; Colonel Fitzclarence; Davies Gilbert, Esq.; Captain Henry Kater; Viscount Melville; Sir George Murray, Bart.; Rev. George Peacock; Sir Robert Peel, Bart.; A. Wilson Philip, M.D.; John Pond, Esq.; George Rennie, Esq.; N. Aylward Vigors, Esq.

President: His Royal Highness the Duke of Sussex, K.G.—*Treasurer:* John William Lubbock, Esq.—*Secretaries:* Peter Mark Roget, M.D, and John George Children, Esq.

Dec. 9.—A paper was read, entitled, "On the performance of fluid refracting telescopes, and on the applicability of this principle of construction to very large instruments." By Peter Barlow, Esq. F.R.S. Corresponding Member of the Institute of France, of the Imperial Academy of Petersburg, &c.

In the first part of this paper the author adduces proofs of the efficacy

efficacy of telescopes constructed with fluid lenses, on the principles developed in his two former papers, published in the Phil. Trans., in separating double stars, resolving nebulæ, and exhibiting different appearances in the discs of the planets. He institutes, with this view, a comparison between the performance of his telescope of 8 inches aperture and 12 feet in length, with Mr. Herschel's telescope, made with his new 20 inches speculum, and with Sir James South's new refractor, of 12 inches aperture and 20 feet focal length. In Mr. Barlow's telescope η Persei, which is marked as double in South and Herschel's catalogue, is seen distinctly sextuple. The stars composing σ Orionis, marked in the catalogue as two distinct sets of stars, each triple, are shown in Mr. Barlow's telescope as being both quadruple, with two very fine stars between them. A very fine double star was discovered by Mr. Herschel between the two which compose β Capricorni, and was considered by him as a very severe test: this star is seen distinctly in Mr. Barlow's telescope, but not double.

Messier's 22nd nebula is resolved by Sir James South's telescope into an immense number of brilliant small stars. In Mr. Barlow's telescope the same resolution is effected, though somewhat less completely.

The two last-mentioned instances he considers as affording excellent criteria of the exact limits of the power of the instrument.

Mr. Barlow next examined Jupiter and Mars in order to compare the defining powers of the two instruments. Both these planets were more sharply defined in Sir James South's telescope than in that of the author, but in this respect the superiority of the former instrument was by no means great: and in the exhibition of the shadow of one of Jupiter's satellites passing over his disc, there was no apparent difference between the two instruments. Their powers seemed as nearly as possible equal when applied to Mars.

An experience of three years has not shown the slightest perceptible change in either the quantity or quality of the fluid employed as the lens of the author's three-inch telescope; neither has the glass inclosing it suffered any diminution of its transparency. The author conceives it therefore to be sufficiently established, that sulphuret of carbon is capable of supplying all the properties of flint-glass, which are required in the construction of a telescope; and moreover, that in consequence of its high dispersive power, it admits of being placed so far behind the principal lens of plate- or crown-glass, as to require to be only one half of the diameter of the latter. This combination also gives a focal power of one and a half times the length of the tube; and consequently the telescope may be reduced in length to two-thirds of that which a glass telescope of the usual construction would require for an equal amount of spherical aberration. In the conclusion of his paper, the author proposes what he considers as a great improvement in the plan of construction for very large telescopes on this principle: it consists in making the object-lenses double, by which their spherical aberration may at once be reduced to about one-fourth of its present amount

amount, and will then admit of easy correction by a fluid lens, without requiring the inconvenient curvatures for its surfaces which are now necessary. This construction will also be attended with the advantage of requiring a much smaller thickness in the plate-glass, and will thus facilitate the selection of proper pieces of glass for being worked into an object lens.

From all these considerations, the author entertains the confident expectation of being able, with proper assistance, to construct a telescope of 2 feet aperture and 24 feet in length, which would as much exceed the most powerful telescopes of the present day, as these exceed the refractors which existed at the close of the last century.

LINNÆAN SOCIETY.

Nov. 2.—The session was commenced by the reading a part of a paper, by John Hogg, Esq. F.L.S. (continued at the subsequent meetings), intitled Observations on some of the Classical Plants of Sicily. The author, who had made a general collection of the plants of the island in 1826, in consequence of the recent publication of the Sicilian Flora, of Presl and Gussone, limits himself in this communications to the classical plants, which he has illustrated by very interesting citations from Theophrastus, Dioscorides, Pliny, the Syracusan poets Theocritus and Moschus, and other writers of antiquity.

Nov. 16.—Read, An account by Lieut.-colonel Bowler, accompanied by drawings, of a curious species of Palm, apparently identical with the Doum Palm of Upper Egypt (*Hyphæne coriacea* of Gærtner), found in the Cutcherry Compound at Masulipatam, and also near Kongaram in the Teloogoo Compound, both in the Government of Madras. The trees were from 18 to 50 feet high, with their stems generally twice forked, but some were found with an elongated simple stem having as many as six heads. The fronds are used by the natives for thatching, and the hard fibrous nuts, when steeped in water and beaten, are made into brushes for white-washing their houses. Colonel Bowler observes, "The Sunasies, whenever they can procure them, carry the stalks of the fronds in their hands, and impose upon the ignorant natives, by attributing to them many surprising virtues, and pretending they cut them from a curious tree which was in a large forest at an incalculable distance.

"The inhabitants of Kongaram and the neighbouring hamlets look upon this tree as the guardian of their jungle, and hold it in some degree of veneration; conceiving it has, as I am told, its Sanscrit name *Kulpa Vroochum** implies, the power of fulfilling the desires and wishes of mankind, at least such as from firmness of heart and morals have faith in its supposed virtues."

* A holy tree in the gardens of Indra. It is said in the Pooranas to have been found in the ocean when Krishna churned it, and that it was given to Indra, telling him that it would grant the wishes of all beings.

The

The tree had probably been introduced from Egypt by the Arabs.

The paper and drawings were communicated by the Council of the Royal Asiatic Society.

Dec. 9.—Read a paper On the plant which yields the Gum Ammoniacum, by Mr. David Don, Lib. L.S.

Although the gum Ammoniacum has held a place in the Pharmacopœia from a very early period, yet the plant itself has hitherto remained wholly unknown. It proves to be a new genus, belonging to the group of *Umbelliferæ*, named by DeCandolle *Peucedaneæ*, differing essentially from *Ferula* and *Opopanax* in its large cup-shaped epigynous disk, and in having solitary resiniferous canals. The specimen was obtained, in the districts where the gum Ammoniacum is collected, by Lieut.-colonel Wright, of the Royal Engineers on his way through Persia from India, and was by him presented along with other dried plants to the Linnæan Society. Every part of the specimen is covered by drops of a gum, possessing all the characters of gum Ammoniacum, and this circumstance alone would seem sufficient to remove all doubt on the subject, but Mr. Don has carefully compared it with the fruit and fragments of the inflorescence found intermixed with the gum in the shops, and he finds them to accord in every respect, so that the plant may now be considered as fully ascertained. Dioscorides derives the name Ammoniacum from Ammon or Hammon, the Jupiter of the Libyans, whose temple was situated in the desert of Cyrene, near to which the plant was said to grow; but as the plant is now ascertained to come from the north of Persia, and not from Africa, Mr. Don is disposed to consider the name Ammoniacum or Armoniacum, as it is indifferently written by ancient authors, as merely a corruption of Armeniacum. We subjoin Mr. Don's essential character of the genus, and some of the more important parts of the detailed description.

Dorema. *Discus epigynus* cyathiformis. *Achenia* compressa, marginata: *costis* 3 *intermediis* distinctis, filiformibus. *Valleculæ* univittatæ. *Commissura* 4-vittata.

Herba (Persica) *robusta, facie ferè* Opopanacis. Folia *ampla, subbipinnata.* Umbella *prolifera, subracemosa.* Umbellulæ *globosæ, breviter pedunculatæ.* Flores *sessiles, lanugini immersi!*

The species is *Dorema Ammoniacum.*

Mr. Don concludes his paper with a few observations on the plant which yields the analogous gum Galbanum, which he regards as constituting also a new genus allied to *Siler*, but differing essentially in the absence of dorsal resiniferous canals to the fruit, and in the commissure being furnished with two only. He proposes for the plant the name of *Galbanum officinale.* The *Bubon Galbanum* of Linnæus possesses neither the smell nor taste of Galbanum, and is altogether a totally different plant.

GEOLOGICAL SOCIETY.

Nov. 3.—In consequence of the Resolutions passed at the general meeting held on the 18th of last June, changing the evenings of

ordinary

ordinary meeting from the first and third Fridays in each month, from November to June, inclusive, to the alternate Wednesdays, the Society assembled on this evening for the session.

The reading of a paper entitled "Remarks on the Formation of Alluvial Deposits," by the Rev. James Yates, M.A. F.L.S., F.G.S., was begun.

Nov. 17.—The reading of the paper on the Formation of Alluvial Deposits, by the Rev. James Yates, begun at the last meeting, was concluded.

After adverting to the importance of this branch of Geology to the successful study of all the more ancient sedimentary deposits, and to the explanation of the methods by which bare rocks are converted into productive soils, the author proposes to describe some of the processes which regulate the production of alluvium, and the principal forms which it assumes.

I.—He considers first those processes of disintegration, not dependent upon the action of running water, by which materials are supplied for the formation of alluvium. These are of two kinds.

1.—Earthquakes and landslips, by which large masses are detached suddenly from the mountains, and fall occasionally with so great an impetus as to extend across valleys.

2.—Other processes, such as frost and oxidation, which are far more important in their effects. The agents of this class always divide rocks according to their natural structure of separation, so that every fragment of the debris is bounded by the plane of its cleavage. The fragments as they fall produce two principal forms; (*a*) the lengthened talus, which in general covers the base of all calcareous, and conglomerate or sedimentary rocks; and (*b*) the acute cone, which is discharged from the ravines of highly inclined schistose rocks, having a cleavage which meets the planes of stratification at an acute angle.

II.—The materials thus furnished are distributed by streams, which round off their angles by continual friction, so as to convert them into pebbles, sand, and mud. The hard and heavy fragments driven along by streams, also wear down the rocks in place, the latter being acted upon according to their degrees of softness and their proneness to disintegration.

When the detritus thus produced is discharged from a lateral into a principal ravine, or valley, the divergence of the stream gives it the form of a cone; but as the force of running water carries loose materials much further than they would fall by their own weight, the form thus produced is not an acute but an obtuse cone. In the Alps some of these obtuse cones attain 500 feet in height, and three miles in diameter, bearing upon their surfaces forests and villages.

The quantity of solid materials descending over the apex of an obtuse cone, is sometimes so great as to stop up the valley. The waters of the principal stream then accumulate above the obstruction, and after the subsidence of the lateral stream, tear away the base

base of the encroaching cone. This form the author designates as the obtuse cone clipt at the base.

Narrow valleys and plains are frequently divided by transverse ledges of gravel. The formation of these is attributed to the operation of rivers, which it is supposed had first accumulated their detritus in dams, and that these dams, having been successively broken down after the subsidence of floods, were re-produced upon a rise of the streams.

Numerous causes are assigned which vary the depth of streams. These are, rains; the melting of Alpine snows and glaciers; the breaking up of ice in rivers; and the bursting of lakes.

III.—Whenever detritus is conveyed by running into standing water, a separation takes place between those finer particles which are held in suspension, and those which it only rolls along the bottom.

As the debris of horizontally stratified rocks forms a lengthened talus at their base, so the loose and heavy materials washed down the side of a mountain, and conveyed into a lake, as soon as they reach its margin fall in a steep slope of the same description. Layer after layer is thus deposited, the result of which is, that a terrace is gradually formed, dipping under the surface of the lake with a gentle slope, and then abruptly terminating in a steep declivity.

The author next endeavours to show, that what is commonly called a Delta is more strictly speaking the Sector of a Circle.

After describing numerous examples of forms of alluvial matter, in artificial reservoirs and in lakes, the author alludes to the probable existence of similar deposits upon a vast scale in the deep and still waters of the ocean; and considering the English, St. George's and Bristol Channels, to be of the nature of estuaries, he observes, that the arc of the Sector is found encircling the south-western extremity of Ireland on the one hand, and the north-western angle of France on the other, and coinciding with a line along which the water deepens suddenly from one to more than two hundred French fathoms.

It is then shown that lakes are filled up, not by depositions in their deep, central water, but by the gradual advance of all their lateral terraces and cones.

IV.—When two streams meet, they neutralize each other's motion, and a deposition takes place at the point of quiescence.

Peculiar appearances ensue, when streams meet at different levels. If a lateral stream brings down a disproportionate quantity of detritus, its bed is raised, but is abruptly terminated by the action of the principal stream. Hence the valleys of mountainous regions exhibit not only level terraces formed in lakes, but others the edge of which have a steep declivity.

Finally, the author presumes that the forms which alluvium puts on in rivers, are produced also in seas, and in the ocean, by the opposition and union of currents flowing either at the same or at different levels.

A short Memoir was then read, entitled "Remarks on the Existence of Anoplotherium and Palæotherium in the lower Fresh-

 water

water Formation at Binstead, near Ryde, in the Isle of Wight," by S. P. Pratt, Esq. F.G.S. F.L.S.

The author lately discovered, in the lower and marly beds of the quarries of Binstead, in the Isle of Wight, and which belong to the lower fresh-water formation, a tooth of an Anoplotherium, and two teeth of the genus Palæotherium, animals characteristic of strata of the same age in the Paris basin.

These remains were accompanied, not only by several other fragments of the bones of Pachydermata (chiefly in a rolled and injured state), but also by the jaw of a new species of Ruminantia, apparently closely allied to the genus Moschus. From the occurrence of the latter fossil, the author infers that a race of animals existed at this geological epoch, whose habits required that the surface of the earth should have been in a very different state from that which it has been supposed to have presented, in consequence of the frequent discovery of the remains of animals who lived almost entirely in marshes.

Dec. 1.—A paper was read, entitled "An Explanatory Sketch of a Geological Map of Moravia, and the West of Hungary," by Dr. A. Boué, For. Mem. G.S. &c.

The author in presenting this Map to the Geological Society, states that it has been made with the assistance of Messrs. Teubner, Rittler, and Von Lill von Lilienbach; and that with the latter gentleman in particular he has recently worked out many details, which it is hoped may rectify certain errors in the great Geological Map of Germany, published by Schropp of Berlin.

Moravia has been in part described by André, Von Albin Heinrich, Von Lill, Von Oeynhausen, and Beudant; but the two last-mentioned writers, it is stated, have not visited the country.

This region is made up of the union of three principal chains of hills, the Eastern or Böhmerwaldgebirge, the Sudeten or Silesian mountains, and the Western Carpathians, the contact of the two first of which is hidden by a red sandstone of the coal-measures, and green, chalk marl.

The hilly region called the Gesenke, consists of grauwacké, and extends across Moravia to near the Bohemian range. The Gesenke is separated from the Carpathians by the tertiary and alluvial valleys of the Upper Oder.

The more ancient and longitudinal valleys, in Moravia, have a general direction from W.S.W. to E.N.E.; and are with some few exceptions, cut through transversely by the present streams.

In the part of Hungary and Gallicia indicated on this Map, the rivers on the contrary flow for the most part in longitudinal valleys, parallel to the Carpathians, as the Nitra, Gran, Vistula, and the Waag, although the latter for a certain space runs through a transversal rent in primary rocks.

In the Western groups are numerous Scotch and Scandinavian minerals. Many of the oldest stratified rocks are crossed by large dyke-like elliptic bodies, running from south-west to north-east. The respective characters of the primary Sudeten and Tatra mountains are then described. The grauwacké districts

tricts are stated to differ little from those of the Hartz and the South of Scotland; and the caverns which abound in the blueish gray limestone, subordinate to this formation, may, the author conceives, have been produced by the acidulous waters which are still so abundant in the country, as at Gefatter Loch, &c. This old limestone formation abounds in Madrepores, Caryophyllia, Encrinites, and Orthoceratites.

The author is of opinion, that the sienite was erupted during the period between the formation of the grauwacké, and the primary chain of Bohemia. This sienite has very various characters, being sometimes porphyritic, at other times associated with talcose and quartzose rocks, &c.

Above the sienite lies a coarse, red conglomerate, which is connected in Bohemia with a great deposit of red sandstone with coal. Here the author corrects an error in Schropp's Map, where the district is coloured as new red sandstone; instead of which, he considers it to be of the age of the Scotch red coal-grits.

The other coal deposit of the basin of the Oder is in aluminous and bituminous slate, with gray sandstone, and many vegetable impressions, but without red sandstone.

The *Zechstein* is wholly absent in these parts, and the true red marl is very scarce.

The *Muschelkalk*, however, occupies some space in Upper Silesia and Poland, and contains most of its characteristic fossils.

The Jurassic and Alpine limestones extend over a large portion of the Map; and the dolomite, the upper beds of which abound with Madrepores, Encrinites, Diceras, and Terebratulæ, is overlaid by the Carpathian or Vienna sandstone (Andrychow, &c.).

The Carpathian sandstone fills a cavity between a range of true Alpine limestone on one side, and Jura limestone on the other, and is easily divisible into three parts.

1. The lowest division is marly and calcareous, containing *Fucoides intricatus* and *F. furcatus*, and has been mistaken on Schropp's Map for transition limestone. It is cut through by dykes of serpentine and greenstone.

2. The middle group is more quartzose.

3. The highest is characterized by reddish marls, several beds of ruiniform, compact limestone, some Fucoides, Encrinites, Lepadites, Tellinites, resembling those of Solenhofen; Possidonia, Terebratulæ, Ammonites, and Belemnites. This triple system of the Carpathians is overlaid by a group of sandstone which the author considers to be the "green-sand;" this is composed of conglomerate, nummulite limestone, and green, calcareous beds with *Gryphæa columba, Ostrea vesicularis*, &c., also with superior beds resembling the *Planer Kalk* of the Germans. The greensand of Moravia has all the characters of that of North-western Europe, passing upwards into a superior, marly greensand, with fossils, and forming long, continuous plateaux. For details the author here refers to previous publications of his own, and to sections with which his Map is accompanied.

Chalk does not exist in the Carpathians, nor could the author recognise it at Cracow, the limestone of which he refers to the Upper Jurassic, although he states that chalk is found in the plains of Poland, Eastern Gallicia, Podolia, Volhynia, and Southern Russia.

The tertiary deposits of the countries described, though belonging to two distinct basins, have everywhere the same characters. The low grounds of Gallicia are supposed to have formed a part of the great basin of Northern Europe, which must have connected the Baltic with the Black Sea, and perhaps with the seas and lakes of Asia. The tertiary beds of Moravia, on the contrary, he considers to have been deposited in an arm of that sea, which must have occupied the great depressions of Hungary and Austria, communicating with the Mediterranean through Bavaria and Switzerland, inasmuch as these deposits, whether on the North or on the South of the Carpathians, have a common character. The various tertiary groups are identified with those of the sub-Apennines ; the blue marls, and yellow, sandy marls, besides the characteristic shells, contain salt, sulphur, gypsum, &c.; and in some parts there are freshwater shells, including the Mytilus of the Danube. In respect to the place of the salt of Wieliczka, the author, differing from MM. von Lill and Keferstein, who had placed it in the Carpathian sandstone, considers it to be of tertiary age, because it is associated with sub-Apennine shells, and is connected with upper marine sandstone, and limestone.

Above the blue saliferous marls is a vast extent of *molasse* with Pectens, Ostreæ, and many fossil vegetables. The beds of this deposit are highly inclined along the foot of the Carpathians. At Nicholschitz and Krepitz in Moravia, and at Zazlusin and Dobromil in Gallicia, it is represented by marly, siliceous deposits, with semiopal, and fishes, as well as Hymenopterous, Dipterous, and Coleopterous insects.

The sandy banks, with Ostreæ and Cerithii, which abound in Moravia, Hungary and Gallicia, are referred to an age intermediate between the blue saliferous marl and the *molasse* just described, and are considered to be older than the conglomerates and coral limestone of Austria.

The older alluvium of these districts, and particularly that of the valley of the Oder, besides boulders and gravel, contains, existing species of fresh-water shells mixed in beds of marl with bones of extinct animals and fossils.

Of basaltic rocks, the cone of Randenberg is scoriaceous, and has been protruded through grauwacké. Near Barrow a felspathose rock has pierced the Carpathic sandstone, converting it into jaspideous rocks resembling those of the Giant's Causeway, and the Isle of Skye, &c.

The author refers to M. Beudant for full particulars of the trachyte, but begs to distinguish certain trachytic conglomerates, as being of aqueous origin, from the trachytic or igneous breccia.

An original "manuscript" Map of all the districts described in the previous

previous Memoir of Dr. Boué, was presented by M. von Lill von Lilienbach, who amongst other novelties has discovered two cones of trachyte near the mercury mines, in the Carpathian sandstone of Krosciensko.

ZOOLOGICAL SOCIETY.

Nov. 9.—R. W. Hay, Esq. in the Chair.

The Chairman opened the business of the Meeting, by stating the objects contemplated by the Council in the formation of the Committee. He explained these objects in conformity with the subjoined Extracts from the Minutes and Report of the Council.

Extracts from the Minutes of Council.

July 21.—"On a consideration of the advantages likely to accrue to the Society, by cultivating an extensive correspondence on subjects of Natural History; it was Resolved, that a Committee be appointed, to be entitled 'The Committee of Science and Correspondence,' for the purpose of suggesting and discussing questions and experiments in animal physiology, of exchanging communications with the Corresponding Members of the Society, of promoting the importation of rare and useful Animals, and of receiving and preparing reports upon matters connected with Zoology.

"That the Committee be requested, in the first instance, to prepare a Report upon the Animals, for the importation of which it is most desirable that the Council should take measures, whether for purposes of utility or exhibition, under the heads of the several countries in which they are produced; and pointing out the means which should be taken for their preservation, either on the passage or after their arrival; and secondly, to obtain all information possible, upon the subject of the importation and breeding of Fish."

Oct. 6.—"It was ordered, that the Committee of Science, nominated at the Council of the 21st of July, should be requested to meet at the Society's rooms, at eight o'clock on Tuesday the 9th of November, and on every subsequent second and fourth Tuesday of the month. It was also Resolved, that the Committee should have power to add to their numbers; and that the members of the Council should be *ex officio* members of the Committee."

Extract from the Report of the Council.

Nov. 4.—"It has been objected to the Council, that but little of their attention has been directed to the advancement of Zoological Science; and the apology which they have to offer is, that their time has been necessarily devoted to the very complicated and extensive arrangements under which the formation of their present establishments has been begun and accomplished. They have latterly been particularly anxious to place the responsibility of detail upon their salaried officers, so that their own time may be principally applied to more general superintendence, and particularly to the encouragement of scientific researches: they have, therefore, endeavoured to establish meetings of such members of the Society as have principally applied themselves to science; at which, communications upon

upon Zoological subjects may be received and discussed, and occasional selections made for the purpose of publication. They propose from time to time to publish in the cheapest form an abstract from the most interesting of these communications; and they trust that the first of these papers will be ready for delivery on the first of January, 1831. They further propose, that these meetings shall take place on the second and fourth Tuesdays in every month; and they have invited, for the 9th of November next, such members of the Society as appeared likely, from their scientific pursuits, to take an interest in their views.

"The Council have moreover suggested that letters be sent to the superintendents of the principal Menageries in Europe, *viz.* at *Paris*, *Leyden*, *Munich*, *Vienna*, *Madrid*, &c. proposing mutual communication of all observations upon these matters, and an occasional interchange of such animals as may be most easily produced or imported in each country. They have also proposed, that circulars be addressed to the Corresponding Members of the Society, requesting particular information upon such facts of Natural History as it may be desirable to investigate at each place; and they further propose that a prize be offered for the Essay which shall contain the best and most extensive practical knowledge upon the importation and domestication of foreign animals in this and other countries."

The Chairman concluded his Address by calling on the Members, collectively and individually, to forward the views of the Council, by communicating such facts as might tend to the advancement of Zoological Science.

Mr. Vigors called the attention of the Committee to a Gallinaceous group of America, which supplied in that continent the place of the *Quails* of the Old World. Of this group, or the genus *Ortyx* of modern authors, which a few years back was known to ornithologists by two well ascertained species only, he exhibited specimens of six species; namely, of *Ort. virginianus* and *californicus*, which had been the earliest described, the former by Linnæus, the latter by Dr. Latham; of *Ort. capistratus*, a species lately named and figured in Sir W. Jardine and Mr. Selby's "Illustrations of Ornithology"; and of *Ort. Douglasii*, *Montezumæ*, and *squamatus*, which had been characterized by himself in the "Zoological Journal". In addition to these species he exhibited plates of three others of which he regretted that he could obtain no specimens in London; namely, of *Ort. macrourus*, figured by Sir W. Jardine and Mr. Selby; of *Ort. Sonninii*, figured by M. Temminck in the "Planches Coloriées" [No. 75.]; and of the *Ort. cristatus*, figured in the "Planches Enluminées" [No. 126.] of M. Buffon. To these nine described species, he added two others apparently new to science, and which he characterized under the names of *Ort. neoxenus* and *affinis*; stating at the same time his doubts whether both might not be the females or young males of the imperfectly known species *Ort. Sonninii* or *cristatus*.—The following are the specific characters of these birds.

ORTYX

Ortyx neoxenus. *Ort. brunneus, supra fusco rufoque undulatim variegatus, subtus pallido-rufo maculatus; genis lateribusque colli rufescentibus; caudâ brunneo-fusco rufoque undulatim fasciatâ; cristâ brevi brunneâ.*

Staturâ minor quàm *Ort. californicus.*

Ortyx affinis. *Ort. pallidè brunneus; dorso alisque fusco pallidoque rufo variegatis; caudâ pallescenti-brunneâ, fusco alboque undulatim fasciatâ; capite, collo, pectore, abdomineque rufescentibus, hoc albo guttato, illis albo nigroque variegatis; fronte apiceque cristæ elongatæ rufo-brunneæ albescentibus.*

Staturâ minor quàm species præcedens.

Mr. Vigors proceeded to state, that individuals of four of the above-mentioned species, namely, *Ort. virginianus, californicus, neoxenus* and *Montezumæ*, had been exhibited in a living state in the Gardens of the Society. Specimens of the former three, he added, were still alive there, having braved the severity of the last winter without any artificial warmth. They were all natives of the northern parts of America. The *Ort. virginianus*, he also mentioned, had bred in this country, and had even become naturalized in Suffolk.

He stated in addition, that Capt. P. P. King, R. N. had pointed out to him, amongst his collection lately brought home from the Straits of Magellan, specimens of a bird which he made no doubt was the same as the *Caille des Isles Malouines* of M. Buffon, figured in the "Planches Enluminées" [No. 222.], and which was subsequently named *Perdix Falklandica* by Dr. Latham. This bird has been added to the genus *Ortyx* by modern authors, but erroneously; as the structure of the wing, in which consists the chief difference between the *Ortyx* of America and the genus *Coturnix* or the *Quails* of the Old World, associates the Magellanic bird more closely with the latter group, than with the birds of its own continent. Mr. Vigors mentioned, that the form which characterizes the true *Quails* extends to Australia, where several species are found. And referring to the deviation in form, which partially separates the South American bird from the allied groups of the same continent, and brings it in contact with those of Australia, and through them with those of the old continent, he dwelt upon the beautiful series of geographical affinity, which in this instance united the zoology of the southern extreme of the New World with that of the nearest portions of the southern hemisphere, in like manner as the zoology of the northern extreme is united with that of the neighbouring continents of Europe and Asia. He pointed out some additional instances, in which the same union might be traced.

Mr. Owen commenced the reading of a paper On the Anatomy of the *Orang Utan* (*Simia Satyrus*, L.).

The subject principally referred to was a young male, probably about four years of age, which had recently been presented to the Society by Mr. Swinton of Calcutta; it reached England in a very debilitated state, and died on the third day after its arrival in Bruton-street.

The morbid appearances met with in its examination were very slight,

slight, and of themselves not sufficient to account for the death of the animal. The brain was firm, and its membranes bore no traces of inflammation. The stomach and intestines were also equally free from morbid appearances. The liver was perfectly healthy, which was the more remarkable, as on the third day before death the *fæces* were clay-coloured from a deficiency of bile. The heart was healthy, except that it had two or three patches of organized lymph upon its surface, indicating old inflammation: the *pericardium* contained more than half an ounce of fluid: about four ounces of fluid were also effused in the cavity of the chest, and the cellular tissue of the lungs was gorged with *serum*, a circumstance which must have occasioned a great obstruction of the circulation. There existed before death evidence of this effusion, in the slow and laboured breathing of the animal, as noticed by Mr. Martin, who also states that the pulse was 100 and very feeble, but, as far as he observed, without intermission. No other organ exhibited any lesion of structure; the lungs and liver were free from tubercles, the developement of which appears to be the most frequent cause of death in animals which, coming from warm countries, have sojourned in our damp climate. The effusion observed may probably be considered as one of the consequences of that debility and exhaustion of the system, produced by a long voyage, improper food, and *diarrhœa*, which terminated in premature death.

The general appearance and position of the abdominal *viscera* in the *Orang* bear much resemblance to those of the human subject. The stomach is thicker and narrower at its pyloric end, and the villous coat is of less extent. The small intestines are lined by a smooth and uniform membrane, and are without *valvulæ conniventes*. The position of the *cæcum* is the same as in man: to its extremity is attached the vermiform appendage, which is wider at its commencement; thus exhibiting as a permanent structure in the *Orang*, that which in man is a fœtal peculiarity. The *colon* is sacculated, and appears, from the existence of *glandulæ solitariæ* and from the presence of lacteal glands in the *meso-colon*, to take a great share in the functions of digestion. The liver generally resembles the human; the gall-bladder is long and tortuous; the *pancreas* is relatively larger, and the spleen more pointed at its extremities than in man; the hepatic and pancreatic secretions enter the *duodenum* separately, but close together. In the structure of the abdominal ring, the *Orang* recedes further than the *Chimpanzee* (*Simia Troglodytes*, L.) from the human type; the kidneys also differ, and present, like those of the *Monkeys* generally, only a single *papilla*. The palate, unlike that of man and of the *Chimpanzee*, has no pendulous *uvula*.

In external form, the brain resembles the human and that of the *Chimpanzee*: it differs from the brains of other animals in the number and disposition of the *laminæ* of the *cerebellum*; in the posterior fissure of that part; and in wanting the transverse band of fibres posterior to the *pons Varolii*. As compared with that of the *Chimpanzee*, the *medulla oblongata* is shorter in proportion, as are also the anterior lobes; and the *cerebellum* projects further behind the *cerebrum*.

cerebrum. The internal structure of the brain has not yet been examined; some previous preparation of that part having been deemed necessary, in order to render it sufficiently firm for dissection.

The structure of the *larynx* is minutely described, and contrasted with the anatomy of the same part in the *Chimpanzee*, in which the laryngeal sacs are not developed as in the *Orang*. The left laryngeal sac in the present instance was the largest, and extended over the top of the *sternum*. In the *Chimpanzee* the laryngeal sac is produced into a cavity in the body of the *os hyoïdes*, presenting the first indication of the excavation which is carried to so great an extent in the *Monkeys* of the genus *Mycetes*. The thyroid gland is small in the *Orang*. The lungs are entire on each side, and not divided into lobes. The *aorta* gives off by a common trunk the right subclavian and the right and the left carotid arteries, the latter of which is given off in the *Chimpanzee*, as in man, from the arch of the *aorta*.

In the course of his illustrations of the anatomical differences which exist between the *Orang* and the *Chimpanzee*, Mr. Owen frequently referred to Tyson's "Anatomy of a Pigmy", and confirmed many of the descriptions given in that work.

Nov. 23, 1830.—Dr. Waring in the Chair.

The following letter from F. Jenkins, Esq., Secretary to the Physical Committee of the Asiatic Society, was read:

"Calcutta, 24th March 1830.

"Sir,—I am directed by the President of the Physical Committee of the Asiatic Society to present, in their name, to the Zoological Society, a small collection of Indian Birds, made (for our Society) by Capt. Franklin (one of its most zealous members) during a late geological tour.

"I am instructed at the same time to state, that it will afford pleasure to the Physical Committee of the Asiatic Society to promote as far as may be in their power, the views of the Zoological Society in this country; and they will be happy to receive communications of their wishes on the subject.

"The collection is in charge of Captain Franklin, who is proceeding in the ship Lady Nugent, to England. I am, &c. &c.

"*N. A. Vigors, Esq.* Sec. Z. S. F. Jenkins."

The collection alluded to in the preceding letter was laid on the table. It was formed by Major Franklin, F.R.S., &c. on the banks of the Ganges, and in the mountain chain of Upper Hindoostan. It contained one hundred and seventy-one species, and was accompanied by drawings of each of the birds, made while they were recent. Mr. Vigors briefly remarked on several of them, as affording interesting illustrations of the extent of the geographical distribution of certain species. He declined to enter at any length into the subject, which he expected would be fully treated of by Major Franklin in a paper which that gentleman was preparing, and which would be communicated to the Committee at an early meeting.

Mr. T. Bell exhibited a pair of living *Acouchies*, (*Olive Cavy*, Penn.,

Penn., *Dasyprocta Acuschy*, Illig.,) recently obtained by him from Guiana. Although they are abundant in their native country, he had never, before the arrival of these individuals, seen a specimen of the species, nor was he aware of the existence of even a preserved skin in any English collection. The *Acouchy* is readily distinguishable from the well-known *Agouti* by its smaller size, its lighter and more elegant proportions, its deeper colours, and other characters, which have been well pointed out by Barrère, Buffon, and other naturalists. The most marked difference is found in the tails of the two animals, that of the *Agouti* being little more than a tubercle, while the tail of the *Acouchy* is upwards of two inches in length; it is slender, and of equal diameter throughout its extent, and resembles a quill, or a portion of a tobacco-pipe. The animal frequently agitates this organ with a quick tremulous motion. Both the individuals are mild and gentle in their dispositions, but somewhat timid; they are, however, familiar with their master, and run to him whenever he enters the room in which they are kept, and about which they are allowed to range during the day. Their food is entirely vegetable; they are especially partial to nuts and almonds: they drink but little. They are extremely cleanly, and take great pains to keep their fur in order, in cleansing which they mutually assist each other. They leap occasionally in play to a considerable height, and frequently on springing from the ground to an elevation of two feet, descend on the spot from which they rose. Their voice is a short, rather sharp, plaintive pur. The individuals, male and female, show great attachment to each other.

Mr. Vigors exhibited specimens of several species of birds, apparently undescribed, from the Himalayan mountains. These formed part of a collection which Mr. John Gould, A.L.S., had lately received from India, and of which he intended to publish coloured illustrations, to the number of one hundred figures. Several of the plates, representing some of the most interesting of the species, were laid upon the table.

Mr. Vigors having called the attention of the Committee to the expedition with which these birds were made known to science—the specimens themselves not having been more than two months in England, while representations of many of them were already within that short space of time brought before the public,—proceeded to make some remarks upon the geographical distribution of the species. He particularly pointed out the identity of a large proportion of their forms with those of Northern Europe; observing that the elevation of their native mountains placed them on an equality in point of climate with the birds of more northern latitudes. At the same time he added that many of the forms peculiar to Southern Asia and the Indian Archipelago were found intermingled with those of the northern regions. Among the forms similar to the European, he particularized three species of *Jays*, the two first of which exhibited a striking affinity in their markings to our well-known British bird. They were named and characterized as follows:

Garrulus lanceolatus. *Garr. vinaceo-badius; capite subcristato, gulâ, jugulo, alisque atris; collo anteriori albo lanceolato;*

lato; pteromatibus remigibusque cæruleo fasciatis, illis albo terminatis; caudâ cæruleâ, nigro fasciatâ, fasciâ latâ apicali albo terminatâ notatâ.

GARRULUS BISPECULARIS. *Garr. pallidè badius, uropygio crissoque albis; maculâ latâ postrictali, caudâ, pteromatibus, remigibusque atris; his duabus cæruleo fasciatis.*

GARRULUS STRIATUS. *Garr. pallidè brunneus, subtus pallidior; corporis supra subtusque plumis in medio albo longitudinaliter striatis; cristâ verticali, remigibus, rectricibusque unicoloribus.*

This latter species was observed to deviate in general colour and markings from the European species, although according in form; and in the former characters to exhibit a manifest approach to the *Nutcrackers*, or the genus *Nucifraga* of Brisson.

A new species of this latter European form was also observed in the collection; a second species being thus added to a group which had hitherto been supposed to have been limited to one. In the shape of the bill, which was somewhat shorter and stouter at the base than in the European species, it indicated an approach to the *Jays*. Its characters were as follow:—

NUCIFRAGA HEMISPILA. *Nuc. castaneo-brunnea; capite subtus, collo anteriori, dorso, pectoreque albo maculatis; capite summo, alis, rectricibusque intensè brunneis; his, duabus mediis exceptis, ad apicem latè albis.*

The two following species of *Woodpecker*, which approached in size and colouring most closely to the European *green Woodpecker*, were also described.

PICUS OCCIPITALIS. Mas. *Pic. viridis, uropygio lutescenti; fronte coccineo; vertice, strigâ latâ occipitali ad nucham extendente, alterâque utrinque sub oculos postrictali, atris; remigibus rectricibusque fusco atris, harum duabus mediis pallido-fusco striatis, illis externè albo maculatis; gulâ genisque canis.*

Fœm. *Fronte atrâ albo lineatâ.*

PICUS SQUAMATUS. *Pic. supra viridis, uropygio sublutescenti; gulâ juguloque viridi-canis; capite coccineo; strigâ superoculari, alterâ suboculari, abdomineque viridi-albis, hoc atro squamato; strigâ superciliari alterâque utrinque mentali atris; remigibus rectricibusque fusco-atris, illis externè, his utrinque albo maculatis.*

A species of *Hawfinch*, according accurately with the characters of that northern form, was also described.

COCCOTHRAUSTES ICTERIOÏDES. Mas. *Cocc. capite, jugulo, dorso medio, alis, femorum tectricibus, caudâque atris; nuchâ, uropygio, corporeque subtus luteis.*

Fœm. *Olivaceo-cana, uropygio abdomineque lutescentibus; remigibus rectricibusque atris.*

As also a small *Owl*, very nearly allied to the *Noctuæ passerina* and *Tengmalmi* of Europe.

NOCTUA CUCULOÏDES. *Noct. brunneo-fusca; capite, dorso, tectricibus alarum, corporeque subtus albo graciliter fasciatis; remigibus externè albo maculatis; rectricibus utrinque fasciis albis quinque notatis; gulâ albâ.*

I 2 Among

Among the forms peculiar to India was observed a second species of the singular group which contains the *Horned Pheasant*, or the *Meleagris Satyra* of Linnæus, and which has been lately separated by M. Cuvier under the name of *Tragopan*. Its specific characters are;

TRAGOPAN HASTINGSII. *Trag. dorso brunneo-fusco undulato, abdomine intensè rubro, amborum plumis ad apicem nigris in medio albo guttatis; cristâ crissoque atris, illâ ad apicem coccineâ, hoc albo maculato; collo posteriori coccineo; thorace aurantio; regione circumoculari nudâ, carunculisque pendentibus luteis; caudâ atrâ, lutescenti-albo undulatâ.*

A species of true *Pheasant*, which seems to have been indicated by former writers from incomplete descriptions or drawings, but never to have been accurately characterized, was also exhibited and named.

PHASIANUS ALBO-CRISTATUS. Mas. *Phas. supra ater, viridi nitore splendens; dorso imo albo-fasciato; cristæ plumis albis, elongatis, deorsim recumbentibus, basi subfuscis; remigibus corporeque inferiori fuscis; pectoris plumis lanceolatis albescentibus.*

Fœm. *Corpore supra cristâque breviori fuscescenti-brunneis; abdomine pallidiore; gulâ, plumarumque corporis apicibus et rhachibus albescentibus; rectricibus lateralibus atris, mediis brunneis albescenti undulatis.*

A third species was likewise added from the collection to the group of *Enicurus* of M. Temminck, which has hitherto been considered as limited in range to the Indian Archipelago. The following are its characters:—

ENICURUS MACULATUS. *En. capite, collo, dorso superiori, pectore, ptilis, remigibus secundariis, caudâque intensè atris; frontis notâ latâ, maculis confertis nuchæ et sparsis dorsi, pteromatibus, dorso imo, abdomine, rectricibus lateralibus, mediarumque apicibus albis; remigibus primariis fuscis; rostro nigro; pedibus albescentibus.*

Staturâ *En. specioso* æqualis.

Mr. Owen resumed the reading of his paper On the Anatomy of the *Orang Utan* (*Simia Satyrus*, L.) This part of the communication is devoted to the osteology of the animal, which is minutely described and contrasted with that of the *Chimpanzee*. With the skeleton of the *Pongo* (*Pongo Wurmbii*, Desm.) the resemblance is in many particulars almost complete; and the extensive examination which Mr. Owen has made of entire skeletons of both the *Pongo* and the *Orang*, and of numerous *crania* of the latter at various ages, has led him to adopt the opinion of those who maintain that these constitute really but one species, of which the *Orang* is the young, and the *Pongo* the adult. The remarkable differences in the crest of the *cranium*, and in the facial angle, appear to be the result of the action of the powerful muscles of manducation, and of the developement of the extremely large *laniarii*.

A marked peculiarity of the *cranium* of the *Orang* exists in the junction of the sphenoid with the parietal bones; a junction which

which is not found in the *Chimpanzee*, and has been asserted to exist in man alone. Other peculiarities are met with, in the absence of a *crista galli* on the ethmoid bone, and in the non-existence of either mastoid or styloid processes: there is a process from the ar ticular surface of the temporal bone, which is necessary to prevent dislocation backwards of the lower jaw, the auditory process not being adapted to prevent such an accident. The intermaxillary bones are distinct. There are large *foramina* behind the deciduous teeth, which lead to cavities containing the permanent ones; the crowns of the latter are as large as those of the *Pongo*. The *os nasi* is single and triangular; it has a strong spine at the back part. There are three infra-orbital *foramina;* and large *foramina* in the malar bone. The anterior condyloid *foramina* are two on each side.

The true *vertebræ* are 23: 7 cervical, with long simple spines; 12 dorsal; and 4 lumbar. There are 8 false *vertebræ*, viz. 5 sacral, and 3 coccygeal. The ribs are 12; 7 true, and 5 false. The *sternum* is composed, below the first portion, of a double series of bones alternating with each other: the same structure obtains in the *Pongo*.

The spine of the *scapula* is strongly incurvated upwards. The bones of the arm and hand are much elongated. The thumb is short; the proximal *phalanges* of the fingers bent.

The *ilia* are narrow, flattened, and elongated. The *femur* is short and straight; it has no *ligamentum teres*, a deficiency which occurs also in the *Elephant*, the *Sloths*, in *Seals*, the *Walrus*, *Ornithorhynchus*, &c., and by which a greater extent of motion is allowed to the thigh. The *tibia* and *fibula* are shorter than the *femur:* these, like the bones of the fore-arm, have a greater interosseous space than is found in man. The *patella* is very small. The *os calcis* projects far behind. The bones of the *metatarsus* and the *phalanges* are elongated, the first series of the latter being bent. The hinder thumb is very short: in the individual examined it had a metatarsal bone, and two *phalanges*. A nail existed on the thumb of each hinder hand.

Dec. 14.—G. B. Greenough, Esq. in the Chair. A letter was read from Dr. Andrew Smith, addressed to N. A. Vigors, Esq. The following are extracts:

“ Cape Town, 8th Sept. 1830.—I am sure you will be pleased to learn that I have discovered another species of *Macroscelides*, as well as a new one of *Erinaceus;* and three species of the genus *Otis*, together with one of *Brachypteryx*. The descriptions of these I hope to be able to forward to you in the course of three weeks or a month. The first is designated in our Museum, *Macroscelides rupestris;* the second, *Erinaceus Capensis;* the third, fourth, and fifth, *Otis Vigorsii*, *Ot. ferox*, and *Ot. Afraoïdes;* the sixth, *Brachypteryx Horsfieldii*. The first was found by myself on the mountains near to the mouth of the Orange river, and the circumstance of its always residing among rocks, together with the difference in its coloring, readily pointed it out as being of a distinct species. As to the colour, the most marked distinction consists in the Cape species having a large tawny rufous or chestnut blotch

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on the nape and back of the neck. The second, *Erinaceus Capensis,* exhibits considerable affinity to the European species, yet betrays such marked peculiarities as to warrant its being considered as really different from it. The third, *Otis Vigorsii,* inhabits the most dry and barren situations in the south of Africa, and is known among the colonists by the name of *Karor Koran.* The prevailing colour above is a light tawny or reddish yellow, and below tawny gray, passing into dirty white on the belly. The back is variegated by numerous violet blotches or reflections, as well as by whitish spots, and the under parts by transverse narrow zigzag black lines. The fourth is above principally tawny yellow, and below dull blueish gray: it is found in the country toward Latakoo. The fifth is met with on the flats near the Orange river, and is called the *Bushman Koran.* With the exception of a great portion of the quill feathers being white, it resembles much the common *Koran* of the colony, the *Otis Afra.* The sixth is met with in high rocky situations, and agrees in most respects with the generic character of *Brachypteryx,* as described by Dr. Horsfield."

With the above letter Dr. Smith transmitted to the Society a present of sixteen specimens of fishes, obtained in the neighbourhood of the Cape of Good Hope, "the details relative to which," he states, "will be forwarded as soon as possible." The specimens were exhibited, and Mr. Bennett laid on the table a list in which they were enumerated as the *Sebastes Capensis, Agriopus torvus, Sciæna hololepidota, Otolithus æquidens, Chrysophris globiceps, Chr. gibbiceps,* and *Pagrus laniarius,* of MM. Cuvier and Valenciennes; an undetermined species of *Dentex;* a fish allied to *Oblada,* Cuv., and apparently the type of a new genus; a new species of *Scomber,* Cuv.; a *Lichia?*; two species of *Clinus,* Cuv., one of which is probably the *Clinus Capensis;* an undescribed species of *Bagrus,* Cuv., of the section distinguished in the "Règne Animal", by having six *cirri* and a rounded and smooth head; a species of *Scyllium,* Cuv., probably new to science; and a second species of the genus *Rhina,* Schn., which deviates from the type by a slight production of the front of the head, and thus makes an approach to *Rhinobates,* Schn.

Mr. Vigors exhibited several species of *Humming-birds* from the collection of Mr. John Gould, one of which, previously undescribed, had been dedicated to Mr. George Loddiges, F.L.S., &c. It approaches most nearly to the *Trochilus Lalandei,* Vieill. but may be distinguished from that bird (in which the crest is brilliantly green and the throat and breast rich blue,) by the following characters:

Trochilus Loddigesii, Gould. *Troch. cristâ elongatâ, purpureo-lilacinâ; gulâ crissoque saturatè cinereis; pectore abdomineque nigris.*

This species is from Rio Grande.

Mr. Loddiges stated that both species belonged to a genus which he had distinguished among the *Trochilidæ* by the name of *Cephallepis;* and promised to bring before the Committee, at an early meeting, the results of his researches on the *Trochilidæ* generally.

At

At the request of the Chairman, Mr. Martin reported the diseased appearances noticed on the examination of the *Beaver* which recently died in the Society's Menagerie. They were stated to be such as result from great and universal inflammation. On examining the stomach, its lining membrane was found covered with a blush of inflammation, prevailing more especially about its cardiac portion, where a number of dark-coloured spots and patches indicated the existence of gangrene. Both the stomach and the *colon* contained undissolved fibres of bark in considerable quantity, the function of digestion having been for some time past necessarily deranged. Along the course of the small intestines, traces of high arterial action were still presented; in the large intestines the traces of inflammation were more obscure. The *pericardium* was highly inflamed, its inner surface presenting a granulated appearance. The heart also, as well as the lungs, gave evidence of having partaken in the general disease. Much disease existed about the lower jaw, which may probably have been the primary cause of all the mischief, as it must have existed for several months, and necessarily have produced a continued state of irritation in the system. The alveolar processes of the lower jaw, embracing the incisor teeth, were destroyed by *caries*, and the teeth themselves had fallen out. In the adjacent soft parts there were extensive abscesses, and a wide spread of discolouration, evidencing the progress of the disorganization.

Mr. Cox exhibited a *Nightingale* in fine plumage and full song, which had been for four years in confinement. He stated that the error generally committed by persons attempting to keep these birds and the other species of *Sylviadæ*, was the over care bestowed upon them. A treatment not more tender than that afforded to granivorous species, agreed well with the *Nightingale*, for which it was by no means necessary to provide insects as food; meat scraped fine and mixed with egg forming a sufficient substitute, and furnishing a nourishment at once grateful to the bird and fully adequate to supply its wants.

Mr. Bennett called the attention of the Committee to two birds which had been for some time living in the Society's Garden. In many respects, especially as regards the nakedness of their cheeks, and the nakedness, length, and reticulation of their *tarsi*, they agree with the *Caracaras* (*Polyborus*, Vieill.); but differ from the type of that genus in the greater compression of their beaks; their transverse oval nostrils; their comparatively slender make; and their more vulturine appearance, which is much increased by the soft downy nature of the plumage of their head and neck. From the genus *Morphnus* of M. Cuvier, which they resemble in many particulars, they are at once distinguished by the length of their wings, which reach, when closed, to the extremity of the tail. He stated his opinion that they would be found, on a close examination, (which could only be made after death,) to constitute a new genus. Until the opportunity of determining this question should occur, he associated them provisionally with the *Caracaras*; and having met with no

no trace of a description of them in any ornithological writer, he proposed for them the following specific character:

POLYBORUS? HYPOLEUCUS. *Pol.? capite, collo, pectore, abdomineque albis; scapularibus fusco-griseis; dorso tegminibusque fuscis; remigibus nigricantibus; caudâ basi nigrâ, apice fasciâ latâ albidâ.*

Jun. *Fuscus, capite, collo, corporeque subtus dilutioribus, remigibus fusco-nigricantibus.*

The following observations, by Mr. Yarrell, on the subject of his attempts to preserve *Whitebait* alive, were read.

"Several dozens of strong lively fish, four inches in length, were transferred with great care from the nets into large vessels, (some of the vessels, to vary the experiments, being of earthenware, and others of wood and metal,) filled with water taken from the Thames at the time of catching the fish. At the expiration of twenty minutes nearly the whole of them were dead, none survived longer than half an hour; and all fell to the bottom of the water. On examination, the air-bladders were found to be empty and collapsed. There was no cause of death apparent. About four dozen specimens were then placed in a coffin-shaped box pierced with holes, which was towed slowly up the river after the fishing-boat. This attempt also failed: all the fish were dead when the vessel had reached Greenwich.

"I was told by two Whitebait fishermen that they had several times placed these fishes in the wells of their boats, but they invariably died when brought high up the river. The fishermen believe a portion of sea water to be absolutely necessary to the existence of this species, and all the circumstances attending this particular fishery appear to prove their opinion to be correct."

A report by Mr. Yarrell on the morbid appearances observed in the examination of the Society's *Reindeer*, was read. It is as follows:

"On opening the body and removing the *viscera*, the lungs appeared highly inflamed, of a dark purple colour; and on cutting into their substance, the cells contained matter. The small intestines also bore marks of inflammation, but in a much less degree: the mesenteric glands were diseased, but not to the extent that might have been expected in an animal that had been many years in an artificial state. The external surface of the neck and head exhibited a high degree of vascularity, and the animal appeared to have been under the influence of that periodical determination of blood to the head, which is known to occur in all deer at the annual production of new horns. As far as the brain could be examined by the occipital *foramen*, both the substance and its investing membranes were also inflamed; but I have no doubt the primary cause of death was the inflammation of the lungs."

Several new species of birds belonging to the collection brought home from the Straits of Magellan by Captain King were exhibited. In the absence of that gentleman, the following species were pointed out by Mr. Vigors, which are thus characterized in Captain King's MSS.

TURDUS

Turdus Magellanicus. *Turd. corpore supra grisescenti-olivaceo, subtus pallidè rufescenti; capite supra, remigibus, caudâque fusco-atris; gulâ albâ, fusco-atro lineatâ.*

Habitat in Fretu Magellanico.

Psittacara leptorhyncha. *Psitt. viridis; fronte, strigâ per oculos, caudâque rufis; capite nigro, abdomine imo rufo, variegatis; mandibulâ superiori elongatâ, gracillimâ.*

Staturâ *Psitt. Lichtensteinii* æqualis.

Habitat in insulâ Chiloe.

Picus melanocephalus. *Pic. capite corporeque supra nigris, hoc albo maculato; pectore abdomineque albis, illo albo lineato, hoc albo fasciato.*

Longitudo 6 vel 7 uncias circiter.

Habitat in Fretu Magellanico et insulâ Chiloe.

Hylactes. Novum genus, *Megapodio* affine.

Characteres Generici:

Rostrum subelongatum, subtenue, apice subemarginato: *naribus* basalibus, longitudinalibus, membranâ subtumescenti pilisque per mediam longitudinem tectâ.

Alæ brevissimæ, rotundatæ; *remige* 5tâ longissimâ.

Cauda subelongata, gradata.

Pedes fortes; *tarsis* subelongatis, in fronte scutellatis; *digitis unguibus*que elongatis, his fortioribus subcompressis; *halluce* fortissimo, incumbente.

Hylactes Tarnii. *Hyl. saturatè fusco-brunneus; fronte, dorso, abdomineque rufis, hoc fusco fasciato.*

Habitat in insulâ Chiloe et Portu Otway sinu Peñas.

Columba Fitzroyii. *Col. vinacea; alis, dorso imo, caudâque plumbeis; hujus fasciâ, remigibusque atris; nuchæ plumis viridisplendentibus; fasciâ occipitali albâ.*

Habitat in nemoribus insulæ Chiloe.

Cygnus anatoïdes. *Cygn. albus, remigibus primariis ad apicem nigris; rostro pedibusque rubris, illo lato, subdepresso, tuberculo nullo.*

Habitat in sinubus interioribus apud extremitatem meridionalem Americæ.

Anser inornatus. Mas. *Ans. albus: dorso inferiori, caudâ, fasciis nuchæ dorsique superioris, femorumque tectricum, pteromatibus, remigibusque atris; rostro nigro, pedibus flavescentibus.*

Fœm. *Capite colloque canis; dorso superiori corporeque inferiori albis, nigro confertim fasciatis; dorso imo, remigibus, rectricibusque nigris; ptilis speculoque albis; tarsis subelongatis.*

Habitat in Fretu Magellanico.

Micropterus Patachonicus. *Micropt. supra plumbeo-grisescens; gulâ scapularibusque rufescentibus; abdomine speculoque alarum albis; rostro viridescenti-nigro, ungue nigro.*

Habitat in parte occidentali Fretûs Magellanici.

Staturâ minor *Micropt. brachyptero.*

Anas chiloensis. *An. fronte, genis, abdomine, uropygio, pteromatibusque albis; capite posteriori, collo, dorso inferiori, ptilis, remigibus primariis, caudâque fuscis; dorso superiori pectoreque fusco*

fusco et albo fasciatis; remigibus secundariis et tertiis scapularibusque nitidè atris, his albo lineatis; abdominis lateribus crissoque rufescentibus; strigâ post oculos latâ splendidè purpurascenti-viridi.

Longitudo circa sexdecim uncias.

Habitat in insulâ Chiloe.

Anas fretensis. *An. gulâ, genis, collo, pectore, dorsoque anteriori pallidè badiis; collo graciliter undulato; pectore dorsoque anteriori atro maculato; dorso abdomineque imis, crisso, caudâque albis nigro fasciatis; dorsi fasciis latis, abdominis gracillimis, caudæ sublatioribus, crissi sparsim undulatis; capite supra, remigibus, scapularibusque viridescenti-atris; his albo in medio lineatis; tectricibus plumbeo-canis, fasciâ apicali albâ: speculo supra viridi, deinde purpureo, fasciâ atrâ apice albo terminatâ.*

Staturâ *Anatis creccoidis*, Nob.

Habitat in Fretu Magellanico.

It was announced that the whole collection of Capt. King's birds, with the descriptions of the remaining new species, would be brought forward at an early meeting.

XII. *Intelligence and Miscellaneous Articles.*

CHLOROXALIC ACID.

M. DUMAS has obtained a compound of chlorine and oxide of carbon, to which he has given the above name. This compound contains the same quantity of oxide of carbon as the chlorocarbonic acid, but combined with only half the quantity of chlorine. It is prepared by treating crystallizable acetic acid with chlorine, exposed to solar influence; the chlorine must be in excess.

It crystallizes in rhombs, is fusible at 45° Fahr., is deliquescent and volatile; it does not act either upon the salts of lime or of silver. Its taste is very remarkable, and is both bitter and sharp. The impression produced upon the tongue is so caustic, that the skin whitens immediately, as if oxygenated water had been applied to it. All the chloroxalates are soluble.—*Le Globe*, 14 October.

POTASH FROM FELSPAR.

According to M. Fuchs, this important alkali may be extracted from minerals containing it, by the following method:—They are to be calcined with lime, then left for some time in contact with water, and the liquor filtered and evaporated. M. Fuchs says he has thus obtained from nineteen to twenty parts of potash from felspar, per cent, and from fifteen to sixteen from mica.—*Royal Inst. Journal. Ann. de l'Industrie*, v. 278.

We presume, from the quantity of potash stated to be obtained from these minerals, that it is estimated in the form of *hydrate*.

NATIVE

NATIVE PHOSPHATES OF MANGANESE AND IRON.

M. Dufrénoy has analysed two varieties of the above-named mineral. The first, to which the name of *Huraulite* is given from its occurring in the Commune des Huréaux, was originally found by M. Alluan in the granite near Limoges. The characters of this mineral are,—that it is crystallized, the crystals being of the size of a pin's head; the primary form is an oblique rhombic prism. It shows no cleavage, its fracture is vitreous, it is transparent, has a reddish yellow colour, scratches calcareous spar, but is scratched by steel; its sp. gr. is 2·27. It fuses very readily, and gives with the blowpipe a black button with a metallic lustre; when heated in a matrass it gives water. It is composed of

Phosphoric acid. . . .	38·0
Oxide of iron	11·1
——— manganese. .	32·8
Water.	18·0
	99·9

The other phosphate of manganese is called Hétéposite; it has been found only in lamellar masses, presenting a three-fold cleavage; the primary form appearing to be an oblique rhombic prism: it has but little lustre, and it is greasy like that of phosphate of lime; its colour is greenish gray, or blueish: when it has been long exposed to the air the colour is a fine violet, and the vitreous lustre is changed to semi-metallic. Its sp. gr., when it has not changed by exposure, is 3·524, but when it has, it is 3·390. It dissolves in acids, except a little silica; and by the blowpipe it fuses into a brown enamel, with a semi-metallic lustre. It is composed of

Phosphoric acid	41·77
Oxide of iron	34·89
Red oxide of manganese.	17·57
Loss by heat	4·40
Silica	·20
	98·83

The double phosphate, analysed by Berzelius, gave

Phosphoric acid	32·80
Protoxide of iron	31·90
——— manganese	32·60
Phosphate of lime . .	3·20
	100·50

It appears, therefore, that these three minerals are composed of different atomic proportions of their constituents.—*Ann. de Chimie*, xli. 347.

ON OXAMIDE. BY M. DUMAS.

Oxamide is a new product formed during the distillation of oxalate of ammonia; its name is derived from the compound which produces it, and which it reproduces. When oxamide is treated with pot-

ash,

ash, 36 parts yield 100 of ammonia, and yet it contains no ammonia; by the same treatment 100 parts give 82 of oxalic acid, and it contains no oxalic acid. These curious properties connect oxamide, on one hand, with the well known formation of ammonia by treating animal matter with potash; and on the other, with the production of oxalic acid by treating vegetable matter with potash, as shown by MM. Gay-Lussac and Vauquelin.

When oxalate of ammonia is subjected to distillation, it suffers a kind of decomposition which M. Dumas had never before observed in any organic substance. It first loses water, its crystals become opaque, it then fuses and boils, but in those portions only which more immediately receive the impression of the fire; when the operation is over, slight traces of a light carbonaceous product remain; the rest being volatilized.

The receiver contains water strongly impregnated with carbonate of ammonia, and a flocculent matter of a dirty white colour is suspended in it. The neck of the retort usually contains crystals of carbonate of ammonia, and a thick deposit similar to the flocculent matter already noticed, both of which are oxamide; this is separated from the carbonate of ammonia by washing on a filter with cold water, in which it is nearly insoluble.

Various gaseous bodies are given out during the distillation, the products being ammonia, water, carbonate of ammonia, carbonic acid gas, oxide of carbon, cyanogen and oxamide; the latter amounts to only about 1-20th of the oxalate of ammonia decomposed.

Oxamide is obtained in the form of confusedly crystallized plates, or in that of a granular powder, which has occasionally traces of yellowish or brown spots, produced by a substance analogous to azulmic acid. When triturated and well washed it is of a dirty white colour, resembling that of uric acid, is inodorous and insipid, and does not act upon coloured papers.

Oxamide is volatile, and when moderately heated the vapour condenses and crystallizes confusedly; but when strongly heated part only sublimes, and the rest is decomposed, giving cyanogen. Boiling water dissolves a small portion, which crystallizes as the solution cools. Oxamide is composed of

	By Experiment.		By Theory.
Carbon	26·95	4 volumes or	27·08
Azote	31·67	2 do.	32·02
Oxygen	36·79	2 do.	36·36
Hydrogen	4·59	4 do.	4·54
	100·00		100·00

Oxamide may therefore be considered either as a compound of cyanogen and water—nitric oxide and bicarburetted hydrogen—or oxide of carbon and an azoturet of hydrogen, different from ammonia: but in whatever light it may be regarded, it is converted into dry oxalate of ammonia by the addition of two volumes of the vapour of water; and when it is treated with potash it is converted into

oxala

oxalate of potash and ammonia; sulphuric acid converts it into sulphate of ammonia, carbonic acid and carbonic oxide: and these changes appear to be effected by the addition of the vapour of water in the proportions above stated.

Many animal substances, such as albumen, gelatin, fibrin, &c., act with potash precisely like oxamide, and the uric and hippuric acids much resemble it in this respect. M. Dumas is occupied in further researches on this subject.—*Ann. de Chimie,* June 1830.

ON TWO KINDS OF FULMINATING GOLD. BY M. DUMAS.

Basil Valentine long since described the remarkable properties of fulminating gold. Three suppositions have been offered respecting its nature: first, that it is an ammoniuret, or a compound of ammonia and oxide of gold; secondly, it has been considered as an azoturet, just as a chloride is produced by the mutual action of oxide of gold and muriatic acid; and thirdly, it has been considered as analogous to salts, the azoturet of gold acting as an acid and ammonia as the base.

One hundred parts of fulminating gold treated with oxide of copper and also with oxide of lead, in the well-known manner, gave from 9·7 to 9·9 of azote and 13 of water; the quantity of chlorine was determined by that of the chloride of silver yielded by the muriate of copper left after analysis; 100 of fulminating gold gave 4·5 of chlorine. The quantity of gold was found by mixing the fulminating gold with ten times its weight of sulphur and gently heating the mixture. When the sulphur is heated to about 302° Fahr. the mass swells, gases are disengaged, and the vapour of sulphur burns. When all the sulphur is expelled, the residue is heated to redness, and pure gold remains, amounting to about 73 or 74 per cent. The necessary corrections being made, fulminating gold appears to consist of

Gold	73·0
Azote	5·0
Ammonia . .	6·0
Chlorine . . .	4·5
Water	11·5
	100·0

These are equivalent to

			By Experiment.
Six atoms of gold	=7458 or	73·6 - -	73·00
Twelve atoms of azote	=1062	10·4 - -	9·88
Two atoms of chlorine	= 442	4·3 - -	4·50
Forty-two atoms of hydrogen	= 263	2·6 - -	2·20
Nine atoms of oxygen	= 900	9·1 - -	10·42
	10125	100·0	100·00

It results from the preceding researches that common fulminating gold is a compound of two atoms of ammoniacal azoturet of gold and one atom of ammoniacal subchloride of gold, with a sufficient quantity

tity of water to convert the azote into ammonia and the gold into oxide.

Scheele and Bergman have shown that oxide of gold when treated with ammonia is converted into a fulminating compound; this compound is undoubtedly different from the foregoing. To ascertain its nature, some oxide of gold was prepared by decomposing a boiling solution of muriate of gold with barytes, which precipitated aurate of barytes, the base of which was removed by dilute nitric acid. The remaining oxide of gold, which was well washed and pure, was put into strong solution of ammonia for twenty-four hours. The powder was washed by decantation, collected on a filter, and dried at 212°.

This powder is of a deep gray or olive colour; it detonates strongly, but its appearance shows that it is different from common fulminating gold. When treated in the manner already described, it yielded

				By Experiment.
Two atoms of gold	=2486	or	77·6	76·1
Four atoms of azote	= 354		11·0	9·0
Twelve atoms of hydrogen	= 75		2·3	14·9
Three atoms of oxygen	= 300		9·1	
	3215		100·0	100·0

In this analysis the azote is not in sufficient quantity, but there is too much for an azoturet, and consequently greatly too much for an ammoniuret. It is probable that during desiccation the ammoniacal azoturet might lose a little ammonia. As, however, Bergman found that 100 of oxide of gold gave 120 of fulminating gold, and as according to the above analysis they should yield 118, it cannot be considered as far from correct.—*Ibid.*

ON THE STATE OF MERCURY IN MERCURIAL OINTMENT. BY M. MITSCHERLICH.

The mercurial ointment employed occupied four weeks in preparing; part of it was set to dissolve at a moderate temperature in alcohol containing caustic potash in solution. The mercury was separated in the metallic state and formed one globule at the bottom of the vessel; the solution was filtered, and the metal was carefully removed from beneath the filter; a white matter remained, which was not removed by washing, and which heated in a tube gave no metallic mercury, nor did it sublime.

From this experiment it appears that the ointment does not contain oxide but metallic mercury. To be certain whether by the reaction of the alcohol and potash the oxide had not been reduced, the following experiment was made: 1·101 gramme of protoxide of mercury was triturated for a long time with lard. The ointment thus prepared was subjected to alcohol mixed with potash as in the preceding experiment. The portion remaining undissolved had not the least appearance of metallic mercury; it weighed 1·196: submitted to distillation with muriatic acid, no metallic mercury appeared, but 1·29 gramme of protochloride of mercury, equivalent to 1·089 of protoxide of mercury. A small portion of the sediment when heated did not sublime.—*Hensman's Repertoire,* August 1830.

MR.

MR. BENNET'S NEW ALLOY FOR THE PIVOT HOLES OF WATCHES.

The injurious effects of jewelled holes in watches and chronometers have been long observed. (See Nicholson's Journal, vol. vii. p. 208.) It seems that, however perfect the polishing may be, sooner or later the hard substance of the jewel grinds and cuts the steel pivot; and the metallic particles, by mixing with the oil, render it unfavourable for action; and this effect is the more likely to take place the nearer the pivots are to the maintaining power. Holes made of brass are objectionable, on account of the liability of this metal to oxidation. Gold is too soft for the purpose. What seems to be required is, a metal, that shall preserve the oil in a pure fluid state, have little friction with the steel pivot, and be in a small degree softer than the pivot, for it is of less consequence that the hole be worn than the pivot. Mr. Bennet, watch-maker, Red Lion-street, Holborn, in a pamphlet on this subject, states that he has discovered an alloy possessing the above-mentioned requisites. It is composed of 3 dwt. of pure gold, 1 dwt. 20 gr. of silver, 3 dwt. 20 gr. of copper, and 1 dwt. of palladium. "The palladium," he says, "readily united with the other metals, and the alloy fused at a temperature rather below that required for melting gold in the separate state. It is very nearly as hard as wrought-iron, and rather brittle, but not so brittle but that it can be drawn into wire. Its colour is a reddish brown; the grain, on breaking, as fine as that of steel; it takes a very beautiful polish; and the friction with steel was much less than that of brass and steel. It is better worked than any metal with which I am acquainted, except brass. Nitric acid had no sensible effect upon it." Mr. B. has constructed a watch with holes made of this alloy, and pronounces the experiment to be successful. If longer trial should confirm this opinion, the small expense of the metal, as compared to that of jewels, will will not be its least recommendation.

Nov. 15, 1830. J. C.

EARTHQUAKES AT THE CAPE OF GOOD HOPE IN 1809.

An Account of the Earthquakes which occurred at the Cape of Good Hope during the month of December 1809. By W. L. von Buchenroder, Esq. Member of the South African Institution. Abridged by the Author from the more detailed Statements read at one of the Meetings of the South Institution.

The occurrence of earthquakes at the Cape of Good Hope on the 4th of December 1809, as well as during several successive days, is yet remembered by numerous residents of the colony; but as far as I know, few if any of the various facts connected therewith, or of the different phænomena which took place, have been collected and recorded. It may therefore not be uninteresting to preserve a faithful account of what was observed, particularly as from the propensity of man to exaggerate any uncommon occurrence, (which was fully exemplified at that period,) as well as from the lapse of time,

time, it will be in a few years more, if not altogether impossible, at least highly difficult to obtain a correct statement of the occurrences as they took place. With such a view the following remarks are submitted to the Institution; and if those members who were in the colony at the time in question would furnish in like manner their individual observations, the object to be wished might readily be accomplished.

Dec. 4, 1809.—Nothing uncommon was observed in Cape Town, either on that day or on those immediately preceding it. The weather was fine, clear, and, as might be expected at the season, very warm. But although it was fine in Cape Town, there was observed throughout the day, as well as during the two or three immediately preceding it, a thick haze over the eastern shore of Table Bay. The wind during the day was S.S.E. and blew a fresh breeze.

In the evening, a little after ten o'clock, three shocks, each accompanied by a tremendous noise, were felt within the space of a minute or two. When the first took place I was sitting in a large company, all the members of which started simultaneously and hastened to the door, the majority exclaiming that a powder-magazine must have blown up; while one gentleman called out that it was an earthquake, adding, he was acquainted with such, from having experienced some on his voyages to the West Indies. While we were standing in the street, the second shock took place, which was felt much stronger; was accompanied by a louder and very tremendous noise, that continued longer than the first; and resembled the report or sound that would be produced by a great many pieces of ordnance fired off by a train, at a little distance. The sound was somewhat hollow, and ended with a rumbling noise, but was not followed by any distinct echo.

This second shock roused all the inhabitants, who came running into the streets in great consternation, many of them even undressed, from having been in bed. Within the space of about a minute, a third shock, but not nearly so violent as the second, and even less so than the first, took place, accompanied also by a similar noise, but less loud, of shorter duration, and more rumbling.

The shocks, as well as the sounds, particularly the rumbling, seemed to come from the North, and to go towards the South. Nothing was perceived however of the wavelike motion of the earth, which has been frequently observed in other countries to accompany earthquakes; and the sensation of the shocks was such as is occasioned by the explosion of a powder-magazine, or the discharge of heavy artillery.

The wind, which had been blowing a fresh breeze from S.S.E., changed at the same time to N.N.W. and then followed a calm. The sky was very clear, the stars shone with great brilliancy, and numerous meteors were observed. In Table Bay nothing was remarked except a heavy swell.

About ten minutes after the third shock, a rumbling noise was again heard, and a shock felt, but inferior, as well in loudness as violence,

violence, to any of the former. I myself, as well as most of the inhabitants, continued either standing or walking in the streets, where we heard rumbling sounds from time to time till about one o'clock in the morning. During that time it continued calm, with the exception of now and then gusts of variable winds.

Dec. 5th.—In the morning, a little after seven o'clock, another shock was felt, accompanied with a sound like thunder. The wind was variable, chiefly westerly and in light gusts.

In walking through the streets of Cape Town I observed that nearly all the buildings had suffered more or less from the shocks during the preceding night, as was evinced by numerous cracks in the walls, the traces of which are yet perceptible in many houses. These were irregular as to direction, and extended generally four, six, or more feet, from the top of the walls, and in a few instances even nearly down to the foundations. Although such were visible on both sides thereof, yet they did not amount to open clefts; and I do not know any instance in Cape Town of a house having received so much damage as to have required it to be rebuilt. The parapets of many were at that time ornamented with figures, urns, &c. of stucco, like to what may yet be seen on a few; and in some instances fragments of those had fallen, and the people were here and there busy in taking down others. I heard also that an old chimney or two had tumbled. No cracks or fissures were observed in the ground in Cape Town.

There were (as might be expected) a variety of reports in circulation with regard to what was seen and heard, most of which were unworthy of attention; yet I cannot omit remarking that many persons concurred in affirming that they had seen large meteors, witnessed their explosions, and experienced the instantaneous shocks, and heard the reports caused thereby. In occurrences like the above, the unadorned narrative of the simplest people is found frequently the most useful in order to come to a matter of fact; wherefore I am induced to give a statement, as it was made unanimously by several slaves, who resided at a house above Green-point, near the corner of Lion's Head. They stated "that they saw something like a wagon illuminated by numerous lights proceed swiftly from the opposite side of Table Bay, or from the direction of Saldanha Bay; that it ascended half-way up Lion's Head, and then turned towards the Marine Villa; that it descended again, and burst when near the sea, and that immediately thereon they felt a shock and heard a tremendous noise."

In Cape Town several people had seen a flash; wherefore they took the first shock and noise for an uncommonly loud clap of thunder, and were only alarmed by the repetition thereof. A farmer on the road near Rondebosch, stated "that he saw a meteor or fire-ball proceed towards and strike the Devil's Hill," and that immediately thereafter the second shock (if I recollect right) occurred.

At about half-past twelve o'clock a loud report or clap was heard, and a shock was felt. The sky at that time was very clear, and the weather warm; with light airs from N.W. In the afternoon, a little

a little before five o'clock, a rumbling, protracted, and moderately loud sound was heard, but no shock was perceived. A few fleecy stationary clouds were observed, which disappeared in the evening. Many inhabitants were busy in pitching tents, and some in placing wagons, in the squares of Cape Town, in which they slept during some weeks. The night was very fine and calm, the sky without clouds, and the stars shone uncommonly clear.

Much interest was excited by what was said to have been observed at Jan Biesjes Kraal, and at Blauweberg's Valley. It was stated "that the earth had opened, that volcanic eruptions had taken place, that craters had been formed, and that lava had issued!" Numbers of persons flocked to these spots, and I went also on the 9th to examine them; but what I found fell considerably short of what I expected from the wonderful accounts I had heard, yet was nevertheless remarkable and interesting. Near the Kraal I found rents and fissures in the ground, one of which I followed for about the extent of a mile. In some places they were more than an inch wide, and in others much less. In many places I was able to push into them, in a perpendicular direction, a switch to its full length, of three or four feet. By the people residing in the vicinity I was informed that they had observed these fissures on the morning of the 5th of December, in some instances three and four inches wide, and that one person had been able to push the whole length of an iron rod, used to fix curtains upon, into them, and that others had been able to do the same with whip-handles of even ten feet in length.

The house at the Kraal in question (the residence of a Mr. Bantjes) I found to have suffered so much, that it was not habitable, and consequently had been evacuated. In the walls were numerous clefts; by which they were rent completely asunder, so that I could put a stick from one side to the other in many places. The clefts extended from the top to the bottom, and corresponded with fissures in the ground.

At Blauweberg's Valley, I found the sandy surface studded with innumerable holes, resembling in shape, but in nothing else, craters in miniature. These holes were from six inches to a foot and a half, and some even three feet, in diameter, and from four inches to a foot and a half deep; of a circular form, and the sides sloping to the centre. They were lined with a crust of blueish clay, of about a quarter of an inch in thickness, which had been baked by the sun, and according to its nature had cracked and curled up in fragments, which however adhered still to the sloping sides of the holes. I reckoned seven of these holes, of different dimensions, in an area, contained within a circle which I drew around me with a walking-stick, and which might have been somewhat more than ten feet in diameter.

The appearance of the blueish baked clay, which had given rise to the story of lava! was easily accounted for, from the rain (a great quantity of which had fallen in the preceding season) having been prevented by the substrata from penetrating and sinking deep

deep into the ground; so that under the sandy surface a considerable quantity of water had collected, in which a portion of the substratum of clay had become dissolved, and which had been forced up through the loose sand by the concussions which took place.

The people at Blauweberg's Valley stated, that "they saw jets of coloured water spout from these holes, to the height of six feet, in the night of the 4th of December, at the time that the shocks were felt."

LIST OF NEW PATENTS.

To W. Church, Haywood House, Birdesly Green, near Birmingham, esquire, for certain improvements in the construction of boats and other vessels, a part of which improvements are applicable to the construction of carriages.—Dated the 21st of September 1830.—6 months allowed to enrol specification.

To F. Molyneux, Hampstead, Middlesex, gentleman, and W. Bunday, Kentish-Town, in the same County, merchant, for certain improvements in machinery for spinning and twisting silk and wool, and for roving, spinning and twisting cotton, flax, hemp and other fibrous substances.—21st of September.—6 months.

To J. Harrison, Wortley Hall, Tankersly, Yorkshire, gardener, and R. G. Curtis, of the same place, glazier, for certain improvements in glazing horticultural and other buildings, and in sash-bars and rafters.—6th of October.—2 months.

To C. Derosne, Leicester-square, gentleman, for certain improvements in extracting sugar or syrups from cane-juice and other substances containing sugar; and in refining sugar and syrups. Partly communicated by a foreigner.—29th of September.—2 months.

To M. Donovan, Dublin, for an improved method of lighting places with gas.—6th of October.—6 months.

To Lieut-Col. L. Walker, C.B. Cumming-street, Pentonville, for a machine or apparatus to effect the escape and preservation of persons and property in case of fire or other circumstances.—6th of October.—6 months.

To R. Pering, Exmouth, esquire, for an improvement on anchors.—6th of October.—6 months.

To J. Heaton, W. Heaton, G. Heaton, and R. Heaton, Birmingham, manufacturers and copartners for certain machinery, and the application thereof, to steam-engines, for the purpose of propelling and drawing carriages on turnpike-roads and railways.—6th of October.—4 months.

To J. Dickinson, Nash Mill, in the parish of Abbotts Langley, Hertfordshire, esquire, for an improved method of manufacturing paper by means of machinery.—6th of October.—6 months.

To W. A. Archbald, Vere-street, Cavendish-square, gentleman, for an improvement in the preparing or making of certain sugars.—13th of October.—6 months.

To D. Napier, Warren-street, Fitzroy-square, engineer, for certain improvements in printing and in pressing machinery, with a method of œconomizing the power applicable to the same, which method of œcono-

œconomizing power is also applicable to other purposes.—13th of October.—6 months.

To F. C. Jacquemart, Leicester-square, esquire, for improvements in tanning certain descriptions of skins. Communicated by a foreigner.—20th of October.—6 months.

To J. B. Sharp, Hampstead, Middlesex, esquire, and W. Fawcett, Liverpool, civil engineer, for an improved mode of introducing air into fluids, for the purpose of evaporation.—20th of October.—6 months.

To A. Craig, Ann-street, St. Bernards, in the parish of St. Cuthberts, Mid-Lothian, for certain improvements in machines or machinery for cutting timber into veneers or other useful forms. Communicated by a foreigner.—20th of October.—6 months.

To A. Ure, Burton Crescent, Doctor of Medicine, for an apparatus for regulating temperature in vaporization, distillation, and other processes.—20th of October.—6 months.

To A. Ure, Burton Crescent, Doctor of Medicine, for an improvement in curing or cleansing raw or coarse sugar.—20th of October.—6 months.

To A. Ure, Southampton Row, Doctor of Medicine, for an air-stove apparatus for the exhalation and condensation of vapours.—20th of October.—6 months.

To S. Clerk, South Down, Brixham, Devonshire, for certain improvements in making or preparing saddle-cloth and girths, for keeping saddles in place on horses and other animals of burthen.—20th of October.—6 months.

To Sir T. Cochrane, knight, (commonly called Lord Cochrane,) Regent-street, for his apparatus to facilitate excavating, sinking, and mining.—20th of October.—6 months.

To T. Mason, No. 56 Great Portland-street, brush-maker, for an improvement in the manufacture of painting-brushes, and other brushes applicable to various purposes.—20th of October.—6 months.

To S. Clegg, No. 16 Sidmouth-street, Gray's Inn Lane, civil engineer, for an improved gas-meter.—20th of October.—6 months.

To H. Calvert, Lincoln, gentleman, for an improvement in the mode of making saddles so as to avoid the danger and inconvenience occasioned by their slipping forward.—26th of October.—2 months.

To J. Shores, Blackwall, Middlesex, boat-builder and shipsmith, for an improvement on tackle and other hooks, which he denominates "the self relieving hooks."—1st of November.—2 months.

To J. Collinge, Lambeth, engineer, for an improvement on the apparatus used for hanging or suspending the rudders of ships, or vessels of different descriptions.—1st of November.—6 months.

To B. Cook, Birmingham, brass-founder, for an improved method of making a neb or nebs, slot or slots, in shells or hollow cylinders of copper, brass, or other metals for printing calicoes, muslins, cloths, silks and other articles.—1st of November.—6 months.

To L. Aubrey, Two Waters, Herts, engineer, for certain improvements in cutting paper.—1st of November.—6 months.

To J. Bowler, Castle-street, Southwark, hat-manufacturer, for certain

certain improvements in machinery employed in the process of dyeing hats.—4th of November.—2 months.

To J. B. Nott, Schenectady, New York, but now of Bury-street, St. James's, esquire, for certain improvements in the construction of a furnace or furnaces for generating heat; and in the application of heat to various useful purposes. Communicated by a foreigner.—4th of November.—6 months.

To T. Bramley, gentleman, and R. Parker, lieutenant in the Royal Navy, both of Mousley Priory, Surrey, for certain improvements on locomotive and other carriages or machines, applicable to rail and other roads; which improvements, or parts or parts thereof, are also applicable to moving bodies on water; and working other machinery.—4th of November.—6 months.

To A. Bell, Chapel Place, Borough of Southwark, engineer, for certain improvements in machinery for removing wool or hairs from skins.—4th of November.—6 months.

To A. W. Gillett, Birmingham, merchant, for an improvement in the construction and application of wheels to carriages of pleasure or of burthen; or to machines for moving heavy bodies. Communicated by a foreigner.—4th of November.—2 months.

To G. C. Bompas, Fishponds, near Bristol, esquire, M.D. for an improved method of preserving copper and other metals from corrosion or oxidation.—4th of November.—6 months.

To J. Gibbs, Crayford, Kent, esquire, for improvements in evaporating fluids, applicable to various purposes.—6th of November.—6 months.

To J. Hall the younger, Dartford, Kent, engineer, for a machine upon a new and improved construction, for the manufacture of paper. Communicated by a foreigner.—9th of November.—6 months.

To G. Minter, Princes-street, Soho, upholsterer, cabinet and chair manufacturer, for an improvement in the construction, making, or manufacture of chairs, which he intends to denominate "Minter's Reclining Chairs."—9th of November.—6 months.

To H. Pratt, Bilston, Staffordshire, miller, for certain improvements in the making and manufacturing of quarries, applicable to kilns for drying wheat, malt and other grain, and to various other purposes.—11th of November.—6 months.

To Sir T. Cochrane, knight (commonly called Lord Cochrane), Regent-street, for an improved rotary engine, to be impelled by steam, and which may be also rendered applicable to other purposes.—11th of November.—6 months.

To C. S. Cochrane, Great George-street, Westminster, esquire, for certain improvements in the preparing and spinning of Cashmere wool. Communicated by a foreigner.—13th of November.—6 months.

To J. Tyrrell, St. Leonard's, Devonshire, esquire, barrister-at-law, for a method and apparatus of setting sums, for the purpose of teaching some of the rules of arithmetic.—13th of November.—6 months.

To T. Sands, Liverpool, merchant, for certain improvements in spinning machines. Communicated by a foreigner.—18th of November.—6 months.

METEORO-

METEOROLOGICAL OBSERVATIONS FOR NOVEMBER 1830.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·40. Nov. 24. Wind N.—Min. 29·10. Nov. 16. Wind S.
Range of the mercury 1·30.
Mean barometrical pressure for the month .... 29·833
Spaces described by the rising and falling of the mercury........... 7·700
Greatest variation in 24 hours 0·570.—Number of changes 14.
Therm. Max. 59°. Nov. 1. Wind W.—Min. 34°. Nov. 23. Wind N.W.
Range 25°.—Mean temp. of exter. air 48°·07. For 30 days with ☉ in ♏ 49·76
Max. var. in 24 hours 16°·00.—Mean temp. of spring-water at 8 A.M. 52·96

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the evening of the 20th ... 93°
Greatest dryness of the atmosphere, in the afternoon of the 25th... 61
Range of the index 32
Mean at 2 P.M. 70°·5.—Mean at 8 A.M. 78°·7.—Mean at 8 P.M. 77·5
—— of three observations each day at 8, 2, and 8 o'clock .... 75·6
Evaporation for the month 1·20 inch.
Rain in the pluviameter near the ground 4·695 inches.
Prevailing wind, S.W.

Summary of the Weather.

A clear sky, 1; fine, with various modifications of clouds, 15½; an overcast sky without rain, 7½; rain, 6.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
21	9	28	1	20	21	21

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
½	1	3	3½	4	13	2½	2½	30

General Observations.—The state of this month has been generally wet and boisterous, with a mild air for the season, excepting a few days. In the afternoon and night of the 6th, a very heavy gale blew here, first from the South, then from South-west, during which time one inch and a quarter of rain fell; but the quantity was much greater in some of the Northern districts, where damage to a considerable amount is said to have been done by the rush of water from the hills, and the consequent inundation of the adjacent lands.

Early in the morning of the 9th a little ice appeared on the ground, being the first time this autumn. In the morning of the 15th a parhelion appeared on the east side of the sun: and at 2 P.M. on the 17th, a faint anthelion was observed on a light cloud opposite to, and nearly of the same altitude as the sun; it was perfectly circular, colourless, and brighter than the cloud in which it appeared, and of the same size as the sun's apparent disc.

The mean temperature of the atmosphere this month is four-fifths of a degree higher than the mean of November for many years past.

The atmospheric and meteoric phænomena that have come within our observations this month, are one anthelion, one parhelion, two solar and three lunar halos, ten meteors, three rainbows, four auroræ boreales, and thirteen gales of wind, or days on which they have prevailed, namely, one from the North, three from the East, one from the South-east, two from the South, and six from the South-west.

AURORÆ

Auroræ Boreales.—At 9 o'clock in the evening of the 1st instant, a bright aurora borealis appeared between the North and West, behind a low *cirrostratus* cloud, which it enlightened in some attenuated places, and several very bright patches were seen in the horizon. At 18 minutes past nine the first column of light emanated from it (whose bearing was due North) to an altitude of about 16 degrees, and was succeeded by ten or twelve more perpendicular columns of various breadths between that point and the magnetic north during a peculiarly bright moon-light, the moon's altitude being from 25 to 30 degrees, and only 28 hours beyond her opposition with the sun. It has been much doubted whether the coruscations of an aurora can be seen in this latitude after the first, or before the last two or three days of the moon's age; but in this instance the strong lunar light had but little influence in diminishing the splendour of these flame-coloured columns. The sky became overcast by 10 o'clock, and did away its appearance.

At half-past seven in the evening of the 4th, an aurora was observed between the North and West, and increased in brighness till eight, when two bright columns of light rose from it, about North-west by West, to an altitude of 22 degrees. Several other columns successively rose between that point and the true North till a quarter past eight, at which time the moon began to rise, but the steady light of the aurora did not disappear till nine. Two bright trained meteors appeared over it, and the thermometer rose one degree. A faint aurora appeared in the evening of the 7th, from 7 till 10 o'clock, without any coruscations; and two meteors appeared over it.

REMARKS.

London.—November 1, 2. Fine. 3—5. Fine: rain at nights. 6. Stormy and wet. 7. Rain in the morning: fine. 8. Fine. 9. Clear and frosty in the morning: fine. 10. Fine: heavy rain. 11. Showery: fine. 12. Fine. 13. Cloudy: rain. 14. Cloudy: rain at night. 15. Cloudy. 16. Rain. 17, 18. Fine in the mornings: cloudy: rain at nights. 19. Fine. 20. Rain. 21. Fine: showers at night. 22. Showery. 23. Fine. 24. Foggy: densely foggy at night. 25. Foggy in the morning; fine. 26. Slight fog: cloudy. 27. Fine: rain. 28. Small rain: fine. 29. Hazy. 30. Drizzly and foggy.

Penzance.—November 1. Fair. 2. Rain: fair. 3. Rain. 4. Fair. 5. Fair: rain. 6. Heavy rain. 7, 8. Clear. 9. Clear: showers. 10. Fair: showers. 11. Fair: hail showers. 12. Fair. 13. Rain. 14. Showers. 15. Fair. 16. Rain. 17. Showers. 18. Clear. 19. Fair: rain. 20. Fair. 21. Fair: showers. 22. Clear: showers. 23. Fair. 24. Misty: rain. 25, 26. Fair. 27. Fair: rain. 28. Rain. 29, 30. Fair.

Boston.—November 1. Fine: beautiful appearance of the Northern Lights, 9 p.m. 2. Fine. 3. Cloudy. 4. Fine. 5. Fine: rain p.m. 6. Cloudy: rain p.m. 7. Cloudy. 8, 9, Fine. 10. Fine: rain p.m. 11. Fine. 12. Cloudy. 13. Cloudy: rain p.m. 14. Fine: rain p.m. 15. Fine. 16. Stormy: rain a.m. and p.m. 17. Fine. 18. Cloudy. 19. Fine. 20. Cloudy. 21. Fine. 22. Rain. 23—25. Fine. 26, 27. Cloudy. 28. Rain, and stormy. 29, 30. Rain.

Meteoro-

Meteorological Observations made by Mr. THOMPSON at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1830.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.									
Nov. 1	30·167	30·141	30·15	30·10	30·17	30·17	29·45	63	44	57	52	59	52	55	W.	NW.	W.	W.	...	...	...	...	...
2	30·151	30·030	30·00	29·96	30·16	30·07	29·47	62	50	56	50	59	52	51	W.	SW.	S.	NW.	...	...	0·055	0·010	...
3	29·942	29·774	29·80	29·70	29·95	29·82	29·33	58	46	58	52	58	47	52·5	S.	SW.	SW.	NW.	0·15	0·11	·180	·080	...
4	29·916	29·842	29·80	29·70	29·91	29·86	29·25	59	46	55	46	57	49	47	S.	SW.	SW.	NW.	...	·01	...	·100	...
5	29·961	29·716	29·75	29·60	29·97	29·74	29·41	59	51	56	48	57	54	46	S.	SW.	S.	W.	...	·08	·300	·180	...
6	29·584	29·182	29·30	29·10	29·60	29·26	29·00	58	49	56	50	59	50	55	S.	S.	SW.	W.	·10	·76	1·420	1·250	0·10
☾ 7	29·455	29·131	29·40	29·10	29·44	29·15	28·64	54	33	52	45	52	42	51·5	SW.	NW.	SW.	W.	...	·05	0·070	·055	·40
8	29·837	29·672	29·85	29·70	29·82	29·65	29·17	54	29	51	44	51	35	41	SW.	NW.	NW.	W.	...	...	...	...	...
9	29·928	29·900	29·85	29·82	29·90	29·87	29·43	54	31	54	40	50	45	36·5	S.	W.	SW.	W.	·10	...	·060	·010	...
10	29·789	29·625	29·65	29·58	29·80	29·65	29·27	56	47	56	46	56	49	46	S.	SW.	SW.	W.	...	·67	·105	·620	...
11	29·688	29·546	29·70	29·58	29·71	29·56	29·00	54	31	54	47	53	42	48·5	SW.	NW.	SW.	W.	...	...	·040	·020	·02
12	30·070	30·003	30·00	30·00	30·06	30·01	29·45	53	30	53	44	51	44	45	SW.	W.	W.	W.	·15	...	...	...	...
13	29·870	29·587	29·50	29·45	29·82	29·60	29·40	53	46	55	47	53	50	45	S.	SW.	S.	W.	...	·09	·300	·190	...
14	29·629	29·528	29·50	29·45	29·60	29·56	29·15	57	41	53	44	54	45	50	S.	W.	SW.	W.	...	·27	·490	·370	·11
● 15	29·643	29·635	29·50	29·50	29·67	29·58	29·12	57	42	56	43	54	52	41	S.	SW.	SW.	W.	·10	...	...	·170	·14
16	29·792	29·096	29·30	28·95	29·35	29·10	28·80	57	30	53	48	56	43	53	S.	SW.	S.	W.	...	·41	·725	·580	...
17	29·673	29·502	29·70	29·40	29·63	29·48	29·00	55	31	50	44	51	36	41	SW.	W.	SW.	W.	...	·03	·075	·100	·25
18	30·056	29·803	30·08	29·80	30·01	29·83	29·33	44	29	50	40	47	34	41	W.	N.	NW.	calm	·15	·02	...	...	...
19	30·231	30·215	30·10	30·02	30·20	30·17	29·72	49	29	51	39	48	42	34	S.	NW.	SW.	NW.	...	·01	·125	...	...
20	30·083	29·973	29·88	29·82	30·01	29·94	29·54	48	30	53	43	51	42	41	S.	W.	SW.	NW.	...	·12	...	·040	...
21	29·955	29·822	29·90	29·80	29·90	29·88	29·47	56	46	54	45	54	48	43·5	S.	SW.	SW.	calm	·10	·23	...	·125	...
22	30·048	29·760	30·10	29·90	30·07	29·77	29·25	55	32	51	48	52	42	48	W.	NW.	W.	calm	...	·04	·200	·005	·08
☽ 23	30·321	30·188	30·30	30·18	30·30	30·17	29·70	51	29	53	47	50	34	38	W.	NW.	NW.	calm	...	...	...	...	...
24	30·459	30·449	30·30	30·25	30·40	30·40	30·02	39	25	52	47	45	40	33	SW.	SE.	SE.	calm	·10	...	·085	...	...
25	30·426	30·357	30·20	30·10	30·33	30·31	30·00	44	27	50	46	48	38	37	E.	SE.	SE.	calm	...	...	...	...	...
26	30·179	29·931	29·90	29·70	30·08	29·85	29·84	42	31	45	42	42	39	41	E.	SE.	E.	E.	...	...	...	...	...
27	29·796	29·576	29·60	29·20	29·70	29·56	29·46	47	36	50	40	50	42	39	E.	SE.	SE.	E	·12	·13	·600	·730	...
28	29·694	29·532	29·30	29·10	29·60	29·47	29·27	48	42	53	42	52	45	42	E.	SW.	SE.	NE.	...	...	·290	·025	·03
29	29·925	29·717	29·60	29·50	29·85	29·75	29·50	45	42	53	46	47	44	42	E.	SE.	NE.	E.	...	·02	...	·020	·17
○ 30	29·977	29·939	29·80	29·75	29·89	29·86	29·55	44	41	50	46	49	42	41·5	E.	E.	E.	calm	·13	...	...	·015	·04
	30·459	29·131	30·30	28·95	30·40	29·10	29·36	63	25	57	39	59	34	44·2					1·20	3·05	5·120	4·695	1·34

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

FEBRUARY 1831.

XIII. *On the Construction of the Berlin Astronomical Ephemeris for* 1832. *By* Professor Encke.*

THE comparison of the end of the last with the beginning of the present volume, has not led to any corrections worthy of being here mentioned, with the single exception (the calculation of the sun's ephemeris having been finished before a small alteration in the tables of correction was published), that in this volume the sidereal time at the mean noon is to be corrected by $-0''\cdot06$. The two preceding volumes gave it correctly. All other discrepancies lie within the limits which are attainable by our tables as at present constructed.

The form of the single parts has remained almost exactly the same as before. The most important difference is one which regards the small planets. The highly respected Dr. Olbers, who continues with an unabated and wonderful vigour of mind to devote his unwearied attention to that science which, in so many of its parts, owes to him the most important improvements and enlargements, has kindly reminded me that, for the more easy finding of the small planets, it would be of consequence to know, besides their distances from the earth, likewise their distances from the sun, in order to be able to estimate the intensity of their light. I have accordingly added a column containing those distances and instead of the three columns 'Rising,' 'Culmination,' and 'Setting,' I have only given two, 'Time of Culmination,' and 'Semidiurnal Arc,' from which the others may be easily calculated.

This subject is connected with a convenient estimation of the light of the small planets at the respective times of their opposition, for which I am indebted to Prof. Bessel, and,

* From Encke's Ephemeris for the Year 1832.

agreeably to which the numbers expressing the intensity of their light have been calculated for the positions of these planets in this year. The unity of these numbers is the light which each of these planets would have, at the time of an opposition at which both the planet and the earth would be at their respective mean distances from the sun; or, if we call the semiaxis major of the orbit a, and denote by r and Δ the distances of the planet from the sun and earth at any opposition, the intensity of the light of the planet at that moment will be $= \frac{a^2(a-1)^2}{r^2\,\Delta^2}$.

The numbers hence resulting for these planets are; for

Vesta............ $\frac{10\cdot43}{r^2\,\Delta^2}$; Juno......... $\frac{19\cdot88}{r^2\,\Delta^2}$

Pallas............ $\frac{24\cdot31}{r^2\,\Delta^2}$; Ceres .... $\frac{23\cdot90}{r^2\,\Delta^2}$,

where the present elements are used. The intensities of light hence resulting, at the different oppositions, are as follows:

	1830.	1831.	1832.
Vesta......	0·77	......	0·79
Juno	1·72	......	1·15
Pallas	0·93	0·31	0·64
Ceres	1·15	0·69	0·87

This manner of estimating the light of a planet seems to be more convenient, because the small planets are principally observed during their oppositions, and the numbers show at once whether they are nearer or more distant. Prof. Bessel has been very attentive to the appearance of Ceres and Pallas at the times of their opposition in 1830. Ceres had the 7th or 8th, Pallas the 8th or 9th magnitude; consequently, when their light is = 1, neither of them will much differ from the 8th magnitude; and the comparison of the light of Pallas at the opposition of 1831, when it will be only one-third of the former, will afford a measure of the actual decrease of the light, as compared with the numbers by which the intensity of light is expressed.

M. Wolfers has for this year also executed a great part of the calculations, namely, the ephemeris of the sun, four months of the moon's geocentric positions, the calculations for Jupiter's satellites, and the superior older planets. To M. Herter I am again indebted for the positions of the moon during four months. M. Lauritz-Ravn undertook Mercury and

and Venus, and M. von Heiligenstein has kindly calculated the positions of Ceres by his own elements, and those of Uranus; the latter calculations perfectly agree with those of M. Wolfers. The places of the stars have been taken from those tables by which Bessel has again afforded one of the most important auxiliaries, for the accurate ascertainment of all the principal elements of astronomy, whose determination was before already, for by far the greatest part, his own work. He has had the kindness to communicate to me those tables in manuscript.

The somewhat smaller number of occultations of stars in this year does not arise from a less careful research, but is principally owing to the circumstance that the moon no more passes through the Hyades. This year is however by no means destitute of important occultations, especially in the case of planets, among which there is a visible occultation of Mercury, which is rather a rare phænomenon. It is likewise distinguished by a transit of Mercury, visible in all Europe, and the transition of the plane of the ring of Saturn through the earth and the sun. It would appear that the latter may be well observed in the morning hours of December, and these observations will perhaps assist in deciding the famous question regarding the period of the rotation of the ring.

In selecting the stars on the parallel of the moon for this year's Ephemeris, a somewhat different principle has been adopted. Mr. Baily has had the kindness to furnish me with a copy of his catalogue of zodiacal stars, from which all those stars have been expunged, which, on account of their inferior light or their vicinity to bright stars, or the possibility of mistaking them for others, appeared less adapted to serve as points of comparison. He expressed, at the same time, the wish that certain stars which he pointed out as convenient, on account of their declinations, for corresponding altitudes, especially in the Observatories of the southern hemisphere, should have a mark of distinction added to them. The stars thus referred to are marked with an asterisk in this year's catalogue.

Mr. Baily however principally wished, and Prof. Struve agrees with him on this point, that in future always one star at least should be common to the successive evenings, in order to afford to travellers in distant regions a means of accurately determining the rate of their time-pieces, as also that, likewise for the advantage of such travellers, the selection of the stars should be made according to the true declination of the moon. Now although this principle of selection has for European Observatories the disadvantage, that astronomers

 must

must devote more time to these observations than is desirable for their other occupations, I have still thought that for the culminations of the evenings I ought strictly to adhere to it. The attempt likewise to apply the same to the morning culminations leads, however, in the first six months, to such small stars that it was altogether abandoned in the latter months.

The shortness of the time, and other circumstances which have likewise retarded the publication of this volume, have not allowed me to fulfil another wish of Mr. Baily, viz. to give the time which the moon employs in passing over the meridian. For this purpose, however, the column ' Moon in the Meridian' may be applied without much trouble. If we denote the difference of right ascension between two successive *inferior* culminations by m, the true declination (as observed from the centre of the earth) of the moon at the intermediate *superior* culmination by δ, and the parallax for the same moment by π, we have, with all necessary exactness, the number of sidereal seconds by which the moon's limb passes sooner or later over the meridian than her centre

$$= \frac{109}{6000} \cdot \frac{360^\circ + m}{360^\circ} \pi \sec \delta$$

$$= [8{\cdot}259275] \; \frac{360^\circ + m}{360^\circ} \pi \sec \delta \; *$$

The following two tables, which might be calculated with more detail, will at once give numbers whose sum is to be increased by the log. of sec. δ, in order to have the logarithm of the above-mentioned number of seconds:

I.

π	$\log \frac{109}{6000} \cdot \pi$	
53′	1·76170	
		812
54	1·76982	
		797
55	1·77779	
		782
56	1·78561	
		769
57	1·79330	
		755
58	1·80085	
		743
59	1·80828	
		730
60	1·81558	
		718
61	1·82276	
		706
62	1·82982	

II.

m	$\log \frac{360+m}{360}$	
10°	0·01190	
		117
11	0·01307	
		117
12	0·01424	
		117
13	0·01541	
		116
14	0·01657	
		116
15	0·01773	
		116
16	0·01889	
		115
17	0·02004	
		115
18	0·02119	

Thus for January 14, 1832, we have $m = 16^\circ\ 4'{\cdot}9$; $\pi = 60'\ 39''{\cdot}4$; $\delta = +18^\circ\ 3'{\cdot}3$, as taken from the Ephemeris,

* [8·259275] means the number whose log. is 8·259275.—Edit.

whence

whence we derive the time of the moon's passage over the meridian in sidereal time thus:

$$\begin{array}{r} 0{\cdot}01897 \\ 1{\cdot}82031 \\ 0{\cdot}02193 \\ \hline 1{\cdot}86121 = 72''{\cdot}65 \end{array}$$

The quantities m, π and δ must be interpolated by the meridian difference from Berlin. For the greater accuracy of these and other reductions, the quantity π has been accurately interpolated, and expressed in tenths of seconds for the time of the culmination in the tables headed 'Auxiliary Tables for the Occultations of Stars.'

Finally, I beg leave to observe that for the more easy distinction of the inferior culminations of the moon, the letter U has been entirely omitted; and that, for the same reason, to the marks of the moon's quarters the following letters have been added:

● N. M. (the initials of the German words for) New Moon.
◐ E. V. .... First Quarter.
○ V. M. .... Full Moon.
◑ L. V. .... Last Quarter.

XIV. *Remarks on the Geology of the Banks of the Tweed, from Carham, in Northumberland, to the Sea Coast at Berwick. By* N. J. Winch, *Esq. Secretary of the Natural History Society of Newcastle-upon-Tyne.*

[Concluded from p. 19.]

In Mr. Smith's present Geological Map of Northumberland, which differs essentially, in that portion of the north of England, from his large map, the red tint, indicative of the new red sandstone, ceases about three miles from the coast, but it is not possible to trace the slightest distinction between the red rocks at West Ord or Berwick Castle, and those connected with the coal and encrinal limestone at Scremerstone*. From the enumeration of the rocks which occur at West Ord, Berwick Castle, the sea-coast, both on the north and south of the harbour, on the hill at Sunnyside, and the shaft of Scremerstone Colliery, there can be no doubt that the red

* To my friend Mr. Fenwick, of Dipton, who has ever kindly furnished me with mining information of a similar description, I am indebted for the section of strata at Scremerstone, and the account of the seams of coal worked

red and variegated sandstones on Tweedside, notwithstanding the

worked in the Berwick district. In a geological point of view, documents of this nature are invaluable.

An Account of the Strata from the Surface to the Main Coal Seam, in the Engine Pit at Scremerstone Colliery.

	FA.	FT.	IN.	FA.	FT.	IN.
Sunk through clay and broken stone ...	3	1	0			
Box further (in the same clay, &c.)		4				
Blue metal		1	3½			
Hard band			6			
Gray band	1	1				
A hard band			4			
Coal, 1			6			
				5	2	7½
Gray bands and metal	2	1	8			
Red sandstone	3	4	2			
White sandstone	3	1	5			
Coal, 2			6			
				9	1	9
Blue metal		2	3			
Gray stone		4	3			
Thill or metal stone		1				
Coal, 3		1				
				1	2	6
Blue metal		3				
Gray stone			6			
Blue metal stone		3				
Red sandstone	1	5	6½			
White post stone		3	4			
Metal		4	8			
Gray stone	1		7			
Gray bands		1				
Metal	1	3	2½			
Gray stone		1	7			
Coal, 4			4			
				7	2	9
Gray stone		4	8			
Hard band			5			
Blue metal		1	4			
Coal, 5		1	2			
				1	1	7
Bandy metal		5	10			
A hard band			6			
Metal		3	7			
White stone		4	11			
Metal		1	6			
White stone	1		10			
Metal		2	10			
Gray band			2			
Metal		3	3			
Coal, 6		1	8			
				5	1	1
Carried forward				30	0	3½

Metal

the presence of gypsum and selenite in the beds at Carham, Wark Castle, and on the Whiteadder, are coeval with the encrinal limestones, and we may safely refer the red beds formerly quarried at Lindesfern, and that accompanied by coal and

	FA.	FT.	IN.	FA.	FT.	IN.
Brought forward				30	0	3½
Metal		2	3			
White stone	1	1	2½			
Metal			6			
White stone	2	1	5			
Metal		1	3			
Gray stone		2	9			
Metal		4	6			
Coal, 7			6			
				5	2	4½
Metal		1				
Limestone		2				
Coarse Coal, 8		1	6			
Gray metal stone			6			
Coarse Coal, 9			10			
Stone			2½			
Rough stone			10½			
Coal, 10. Main Coal, Scremerstone		4	3			
				1	5	2
Boring from the Main Coal Seam, towards the Cancer Coal.				37	1	10
Blue metal	1	5	5			
Girdle			5			
Blue metal		3	4			
Girdle			6			
Blue metal parting			3			
Post girdle			11			
Coal		2	3			
Band			6			
Coal			10			
				3	2	5
Blue metal		1	6			
Girdle			4			
Parting			1			
Girdle			5			
Brown metal		2	9			
Coal			5			
					5	6
Brown metal		1	5			
Coal			7			
Brown metal		1	9			
White freestone	1	1				
Red freestone	1	1				
White freestone	11		5			
Parting			3			
Carried forward	14	0	5	41	3	9

White

and blue limestone in the vicinity of Edinburgh* to the same series of rocks. In the Newcastle coal-field, where no limestone is interstratified with the measures, red sandstone differing in no respect from those just mentioned may be noticed near the sea-coast of Northumberland at Cresswell, Ellingham, Woodhorn, Newbiggin, Tynemouth; also at Burrowdon, in the neighbourhood of Gosforth.

As

	FA.	FT.	IN.	FA.	FT.	IN.
Brought forward	14	0	5	41	3	9
White freestone		1				
Coal: the seam probably may be the Cancer coal		2				
				14	3	5
Gray metal			6			
Limestone		3	6			
Gray metal		4	8			
Coal			6			
				1	3	2
Gray metal		1	4			
White freestone		3	9			
Limestone			6			
White freestone		4	5			
Limestone		3	2			
				2	1	2
				59	5	6

Observations on the Seams of Coal in the Berwick District.

The seams of coal near the sea coast in this district, generally dip nearly due east, at an inclination of one yard in three; to the westward, their dip is to the southward of the east, with an inclination of one yard in ten or twelve.

1st. The Muckle Howgate Seam is the first workable bed on the Scremerstone estate, and in its vicinity; it lies at various depths below the surface, and is about two feet six inches in thickness; it is considered an inferior coal in quality, and used only for burning limestone.

2nd. The Caldside Seam, supposed to be about sixty fathoms below the Muckle Howgate Seam, is generally used for the same purpose, though rather of a better quality than No. 1.

3rd. The Scremerstone Main Coal, supposed to be about sixty fathoms below the Caldside Seam, is four feet in thickness, but with a thin band of stone near its bottom. This seam is reputed the best coal for house use, except the portion nearest the bottom, which is sold for lime-burning.

4th. The Stony Coal lies from two to three fathoms under the Scremerstone Main Coal: its thickness is about four feet, including a band of stone of twelve inches in its middle. This seam of coal is not reputed so good as No. 3. It has been worked, but to no considerable extent, near Berwick.

5th. The Cancer Coal is supposed to be from twelve to fifteen fathoms below the stone coal, but the distance beween them varies. The seam has not been worked in the eastern part of the district, lying at a considerable

* Mr. Dunn's M.S. Section of Gilmerton Colliery.

depth

As investigation advances, the lines of demarcation between different formations seem to vanish, and doubts are left upon the mind even whether distinct epochs have at any period intervened beween the commencement and termination of the consolidation of secondary strata. The mineralogical characters of rocks are now acknowledged to be no satisfactory evidence of geological position; for by hand specimens, who can point out the difference between the red sandstones, associated with coal and encrinal limestone at Berwick, or with magnesian limestone in the county of Durham? If the mode of concretion is called to our aid, we find the oolitic form is assumed, not only by the limestone usually denominated oolite, but by the magnesian limestone at Hartlepool (Geological Transactions, vol. iv. p. 7), and by the encrinal limestone at Warcop in Westmoreland, as noticed by Mr. Fryer many years since. Dolomite is interstratified with the carboniferous or encrinal limestone in Derbyshire, as is chert in the lead measures at Arkengarthdale in Yorkshire (Geol. Trans. vol. iv. p. 63); but neither of these remarkable strata occurs in the lead-mine district of Durham or Northumberland, though a part of the same chain of hills; nor can the identity of millstone grit be here depended upon as in Derbyshire, for one bed at least of this apparently well-defined rock, is associated with coal measures at Hauxley, Widdrington, Ulgham,

depth in that situation; but at Thornton, Shoreswood, Gatherick, and some adjoining places in the western part of the district, it is worked under the name of the Main Coal. Its thickness is from five to five and a half feet, and its quality is not good, the bed being traversed by thin bands of stone.

6th. The Three-quarter Coal lies at variable distances below the Cancer Coal, being in some places found at twelve, and at others twenty-two fathoms deeper than that seam. Its usual thickness is two feet eight inches, including a band of stone of ten inches; its quality is inferior to the better coals of the district.

7th. The Cowper Eye Seam is generally met with about four fathoms below the Three-quarter Coal; it varies in thickness from two to three feet of saleable coal, having a stone band in its middle, unequal in thickness, but in some situations exceeding two feet. This seam is chiefly worked in the western part of the district, as at Murton, Thornton, Shoreswood, Felkington, Etal, Gatherick, Greenowalls, and their vicinity. In quality, it is considered equal to No. 3, Scremerstone Main Coal.

No. 8. The Western Coal Seam appears to me to be the lowest worked in the district. It has been sunk to at Shoreswood, and there found at about fourteen fathoms below the Cowper Eye Seam; but the quality being indifferent, it was not thought worth working. At Etal there is a mine carried on in it, though even there the coal is of inferior quality.

From the gradual rise of the strata to the westward, the first four seams mentioned in the section of the strata near Berwick, do not reach to Thornton, Shoreswood, Felkington, Etal, Gatherick. Greenowalls and Nos. 5, 6, 7, and 8, are the beds worked at those coal-mines.

Berwick Hill near Mason Dinnington, and Heddon-on-the-Wall, and another traverses the country to the westward, from the sea-coast in the vicinity of Howick and Warkworth by the Helm-on-the-Hill, Netherwitton, Roadley, Shaftoe Crags near Wallington, and Stamfordham. Basalt being evidently the production of fire, and pervading in an irregular manner rocks of almost every age, does not come within the scope of these remarks; so that the similarity of organic remains has at length become the geologist's chief guide and reliance, in proving or endeavouring to prove the identity of formations; but if I mistake not these exuviæ will not always warrant the conclusions drawn from their presence.

XV. *On the Limits upon the Earth's Surface within which an Occultation of a Star or Planet by the Moon is visible.* By J. W. Lubbock, *Esq. F.R.S.**

A STAR is occulted at all those points which coincide at any instant with the intersection of a cone circumscribing the moon, and whose apex coincides with the star in question and the earth's surface; and the star will be just occulted, or appear to graze the moon's edge at those points which coincide with the intersection of a plane perpendicular to the moon's orbit, and passing through the star and the centre of the moon, with the earth's surface. In order, therefore, to determine the limits within which the occultation is visible, it is necessary to find the equation of this cone and plane.

On account of the small diameter of the moon and the great distance of the star or planet, the cone in question may be considered as a cylinder whose axis coincides with the line joining the centres of the moon and the star, which axis is parallel to a line joining the centre of the earth and the star.

Let $F(x, y, z) = 0$, $F'(x, y, z) = 0$, be the equations to any curve, $x = az + x_{,}$, $y = bz + y_{,}$ the equations to any straight line, the equation to the cylinder whose axis coincides with the line in question and has the curve $\{F(x, y, z) = 0$ $F'(x, y, z) = 0\}$ for its base, may be found by eliminating x, y, z between the four equations $\{F(x, y, z) = 0$, $F'(x, y, z) = 0$ $x = az + x_{,}$ and $y = bz + y_{,}\}$ and then putting for $x_{,}$ and $y_{,}$ their values $x - az$ and $y - bz$ in the resulting equation. The following method however in some cases is perhaps more simple.

Let $x'^2 + y'^2 = r^2$ be the equation to the cylinder in ques-

* Communicated by the Author.

tion

tion referred to coordinate axes which have their origin at the moon's centre; the axis z of course coinciding with the line which joins the centres of the moon and the star, and r being the radius of the moon.

Let x_1, y_1, z_1, be the coordinates of the centre of the moon referred to the centre of the earth, the plane xy coinciding with the equator, x_2, y_2, z_2 the coordinates of the star referred to the same axes, and let

$$x' = a\,(x - x_1) + b\,(y - y_1) + c\,(z - z_1)$$
$$y' = a'\,(x - x_1) + b'\,(y - y_1) + c'\,(z - z_1)$$
$$z' = a''\,(x - x_1) + b''\,(y - y_1) + c''\,(z - z_1)$$

The equation to the cylinder referred to the axes x, y, z is

$$\{a\,(x - x_1) + b\,(y - y_1) + c\,(z - z_1)\}^2$$
$$+ \{(a'\,(x - x_1) + b'\,(y - y_1) + c'\,(z - z_1)\}^2 = r^2$$

The equation to the plane $x'y'$ is

$$a''\,(x - x_1) + b''\,(y - y_1) + c''\,(z - z_1) = 0.$$

If α_1 and δ_1 denote the right ascension and declination of the moon, and α_2, δ_2 of the star, since the plane $x'y'$ is perpendicular to a line joining the centre of the moon and star, it is easy to show that

$$a'' = \cos\alpha_2 \cos\delta_2, \quad b'' = \sin\alpha_2 \cos\delta_2, \quad c'' = \sin\delta_2.$$

The following well-known equations of condition obtain between the quantities $a, b, c, \; a', b', c', \; a'', b'', c''$:

$$\begin{aligned} a\,a' + b\,b' + c\,c' &= 0 \\ a\,a'' + b\,b'' + c\,c'' &= 0 \\ a'a'' + b'b'' + c'c'' &= 0 \\ a^2 + b^2 + c^2 &= 1 \\ a'^2 + b'^2 + c'^2 &= 1 \\ a''^2 + b''^2 + c''^2 &= 1 \end{aligned}$$

Since these equations are more than are necessary to determine these quantities, we may suppose one of them as $c = 0$, and then it is easy to show that

$$a = \sin\alpha_2, \qquad b = -\cos\alpha_2$$
$$a' = \cos\alpha_2 \sin\delta_2, \quad b' = \sin\alpha_2 \sin\delta_2, \quad c' = -\cos\delta_2,$$

and the equation to the cylinder becomes

$$\{(x - x_1)\sin\alpha_2 - (y - y_1)\cos\alpha_2\}^2$$
$$+ \{(x - x_1)\sin\delta_2\cos\alpha_2 + (y - y_1)\sin\alpha_2\sin\delta_2$$
$$- (z - z_1)\cos\delta_2\}^2 = r^2$$

If $x = R\cos\phi\cos\alpha_3, \;\; y = R\cos\phi\sin\alpha_3, \;\; z = R\sin\phi$, ϕ being the geographical latitude of a point on the earth's surface, and if Π be the moon's horizontal parallax, $\triangle$ her apparent semidiameter,

$$\begin{aligned}&\{\cos\delta_1 \sin(\alpha_2-\alpha_1) - \Pi\cos\phi\sin(\alpha_2-\alpha_3)\}^2 \\ &+ \{\cos\delta\ \sin\delta_2\cos(\alpha_2-\alpha_1) - \sin\delta_1\cos\delta_2 \\ &\quad - \Pi(\cos\phi\sin\delta_2\cos(\alpha_2-\alpha_3) - \sin\phi\cos\delta_2\}^2 = \Delta^2\end{aligned} \quad (1)$$

Let ω be the inclination of the moon's orbit to the equator, ν the right ascension of its intersection with the equator; then the equation to her orbit is

$$x\sin\omega\sin\nu - y\sin\omega\cos\nu + z\cos\omega = 0$$

The equation to a plane passing through the star and the centre of the moon and perpendicular to this plane is

$$\begin{aligned}&(x-x_1)(\cos\omega\cos\delta_2\sin\alpha_2 + \sin\delta_2\sin\omega\cos\nu) \\ &+(y-y_1)(\sin\omega\sin\nu\sin\delta_2 - \cos\delta_2\cos\alpha_2\cos\omega) \\ &-(z-z_1)(\sin\omega\cos\delta_2\cos(\alpha_2-\nu) = 0,\end{aligned}$$

and putting $R\cos\phi\cos\alpha_3$ for x, $R\cos\phi\sin\alpha_3$ for y, and $R\sin\phi$ for z,

$$\begin{aligned}&\Pi\{\cos\phi\sin\delta_2\sin\omega\cos(\nu-\alpha_3) + \cos\phi\cos\delta_2\cos\omega\sin(\alpha_2-\alpha_3) \\ &\qquad - \sin\phi\cos\delta_2\sin\omega\cos(\alpha_2-\nu)\} \\ &-\cos\delta_1\sin\delta_2\sin\omega\cos(\nu-\alpha_1) - \cos\delta_1\cos\delta_2\cos\omega\sin(\alpha_2-\alpha_1) \\ &\qquad + \sin\delta_1\cos\delta_2\sin\omega\cos(\alpha_2-\nu) = 0,\end{aligned} \quad (2)$$

the geographical longitude east of the point corresponding to $\alpha_3 = \alpha_3 -$ the sidereal time at the place from which longitudes are reckoned.

Equation (1) may be considered as the equation of a cone having its apex at the earth's centre, the variables being ϕ and α_3. This determines the points on the earth's surface for which the star is occulted at any instant; the intersection of this cone with the plane, Equation (2), determines the points at which the star is just occulted or appears to graze the edge of the moon. The mathematical solution here given comprehends also those points on the opposite hemisphere of the earth to the moon, which are intersected by the cylinder and plane, and which must obviously be excluded.

XVI. *Tables of the Decimal Parts of a Day and an Hour.* By A CORRESPONDENT.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

AS I see that in a former Number of your Journal you have commenced a publication of correct Tables requisite in practical astronomy, I forward two of the same nature, in the hope that other correspondents may be induced, like myself, to follow so useful an example.

December 10, 1830.

Table

Table of the decimal Parts of a Day.

	Hours.	Minutes.			Seconds.			
1	0·04167	0·000694	31	0·021528	1	0·00001157	31	0·00035880
2	0·08333	0·001389	32	0·022222	2	0·00002315	32	0·00037037
3	0·12500	0·002083	33	0·022917	3	0·00003472	33	0·00038194
4	0·16667	0·002778	34	0·023611	4	0·00004630	34	0·00039352
5	0·20833	0·003472	35	0·024306	5	0·00005787	35	0·00040509
6	0·25000	0·004167	36	0·025000	6	0·00006944	36	0·00041667
7	0·29167	0·004861	37	0·025694	7	0·00008102	57	0·00042824
8	0·33333	0·005556	38	0·026389	8	0·00009259	38	0·00043981
9	0·37500	0·006250	39	0·027083	9	0·00010417	39	0·00045139
10	0·41667	0·006944	40	0·027778	10	0·00011574	40	0·00046296
11	0·45833	0·007639	41	0·028472	11	0·00012731	41	0·00047454
12	0·50000	0·008333	42	0·029167	12	0·00013889	42	0·00048611
13	0·54167	0·009028	43	0·029861	13	0·00015046	43	0·00049769
14	0·58333	0·009722	44	0·030556	14	0·00016204	44	0·00050926
15	0·62500	0·010417	45	0·031250	15	0·00017361	45	0·00052083
16	0·66667	0·011111	46	0·031944	16	0·00018519	46	0·00053241
17	0·70833	0·011806	47	0·032639	17	0·00019676	47	0·00054398
18	0·75000	0·012500	48	0·033333	18	0·00020833	48	0·00055556
19	0·79167	0·013194	49	0·034028	19	0·00021991	49	0·00056713
20	0·83333	0·013889	50	0·034722	20	0·00023148	50	0·00057870
21	0·87500	0·014583	51	0·035417	21	0·00024306	51	0·00059028
22	0·91667	0·015278	52	0·036111	22	0·00025463	52	0·00060185
23	0·95833	0·015972	53	0·036806	23	0·00026620	53	0·00061343
24	1·00000	0·016667	54	0·037500	24	0·00027778	54	0·00062500
25		0·017361	55	0·038194	25	0·00028935	55	0·00063657
26		0·018056	56	0·038889	26	0·00030093	56	0·00064815
27		0·018750	57	0·039583	27	0·00031250	57	0·00065972
28		0·019444	58	0·040278	28	0·00032407	58	0·00067130
29		0·020139	59	0·040972	29	0·00033565	59	0·00068287
30		0·020833	60	0·041667	30	0·00034722	60	0·00069444

Table of the decimal Parts of an Hour or of a Degree.

Minutes.				Seconds.			
1	0·016667	31	0·516667	1	0·000278	31	0·008611
2	0·033333	32	0·533333	2	0·000556	32	0·008889
3	0·050000	33	0·550000	3	0·000833	33	0·009167
4	0·066667	34	0·566667	4	0·001111	34	0·009444
5	0·083333	35	0·583333	5	0·001389	35	0·009722
6	0·100000	36	0 600000	6	0·001667	36	0·010000
7	0·116667	37	0·616667	7	0·001944	37	0·010278
8	0·133333	38	0·633333	8	0·002222	38	0·010556
9	0·150000	39	0·650000	9	0·002500	39	0·010833
10	0·166667	40	0·666667	10	0·002778	40	0·011111
11	0·183333	41	0·683333	11	0·003056	41	0·011389
12	0·200000	42	0·700000	12	0·003333	42	0·011667
13	0·216667	43	0·716667	13	0·003611	43	0·011944
14	0·233333	44	0·733333	14	0·003889	44	0·012222
15	0·250000	45	0·750000	15	0·004167	45	0·012500
16	0·266667	46	0·766667	16	0·004444	46	0·012778
17	0·283333	47	0.783333	17	0·004722	47	0·013056
18	0·300000	48	0·800000	18	0·005000	48	0·013333
19	0·316667	49	0·816667	19	0·005278	49	0·013611
20	0·333333	50	0·833333	20	0·005556	50	0·013889
21	0.350000	51	0·850000	21	0·005833	51	0·014167
22	0·366667	52	0·866667	22	0·006111	52	0·014444
23	0·383333	53	0·883333	23	0·006389	53	0·014722
24	0·400000	54	0·900000	24	0·006667	54	0·015000
25	0·416667	55	0·916667	25	0·006944	55	0·015278
26	0·433333	56	0·933333	26	0·007222	56	0·015556
27	0·450000	57	0·950000	27	0·007500	57	0·015833
28	0·466667	58	0·966667	28	0·007778	58	0·016111
29	0·483333	59	0·983333	29	0·008056	59	0·016389
30	0·500000	60	1·000000	30	0·008333	60	0·016667

XVII. *On the alleged Production of Heat in Mines by the Condensation of the Air which ventilates them; and on the Fallacy of other Objections to the Opinion that a high Temperature exists in the Interior of the Globe.* By ROBERT W. FOX.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

A PAPER has recently appeared in the Edinburgh Review* "On the Progress of Geological Science," in which arguments are adduced against the existence of an elevated temperature in the interior of the earth.

These arguments are founded on the cold which prevails about the poles, notwithstanding they are twelve miles nearer the centre than the surface of the earth is at the equator; and on the comparatively low temperature of the water in abandoned mines, as well as at the bottom of the sea, as far as this has been ascertained.

It is at the same time admitted that the heat is found to increase in mines in proportion as they are deepened, and that its degree depends on their depth under the surface, rather than with respect to the level of the sea. That it is not produced by the miners, and the candles and gunpowder they use, is fully acknowledged, as the influence of those causes must be perfectly insignificant on the large quantity of water pumped out of deep mines.

But the reviewers attribute the elevation of temperature observed in mines to the condensation of the currents of air which ventilate them. "Now," they say, "as this air passes from the surface to the bottom of the mine †, it becomes more and more compressed. Its temperature in consequence must be continually increasing, and of course it must be always giving out heat to the walls of the mine and to the water with which it comes in contact. The heat given out at the bottom will be greatest, because there the compression is greatest. The greater the quantity of air thus condensed, and the more rapid the current, the greater will be the quantity of heat evolved. This, we are persuaded, is the true cause of the elevation of temperature as a mine increases in depth."

These opinions, proceeding from such authority, induce me, from the part I have taken in this question, and the opportunities I possess, from my local situation, for getting information relative to the Cornish mines, to offer a few remarks

* Edinburgh Review, No. 103, p. 49—52.

† Dolcoath is the mine referred to, and 84° the temperature of the water at the bottom, the mine being 238 fathoms deep.

for

for the purpose of showing that neither the hypothesis, nor the objections derived from the temperature of abandoned mines, are tenable.

I do not apprehend that a degree of pressure equal to what takes place in our deepest mines would raise the temperature of air many degrees, probably not more than five or six at the utmost, supposing none of the heat to escape to surrounding bodies; but the water flows into some of our mines in considerable streams at the temperature of from 80° to 90°, which is about 30° to 40° above that of the climate: and nearly two millions of gallons are daily pumped from the bottom of Poldice mine, which is 176 fathoms deep, at 99° to 100°. This being warmer than the human body, of course puts that source of heat out of the question; and it often happens that streams of water, the moment they gush into mines, are equal and sometimes superior in temperature to the air immediately in contact with them.

Neither do the seasons seem to produce any sensible effect in deep mines, which they doubtless would do if the heat were in almost any degree attributable to the compression of the air.

Our mines are for the most part ventilated by shafts opening into the levels or galleries from the surface or from a higher level. These shafts are commonly numerous in extensive mines, and the air circulates freely and often copiously through them, ascending in some shafts, and descending in others. In all cases, I believe that the upward currents are at a higher temperature than the downward ones; so much so, indeed, that in winter the moisture is often frozen in the latter to a considerable depth, and not at all in the former. The temperature of these currents has recently been ascertained in some mines.

In Dolcoath the air ascended in one shaft at 60°, and descended in another at 51°:—the thermometer was placed six feet down in these shafts.

In Poldice a current came up at 61°, and another went down at 48°, both having been observed at thirty feet below the mouths of the shafts.

In Tingtang mine, which is 178 fathoms deep, the thermometer was let down fifteen feet in two shafts, and indicated a temperature of 59° in the ascending, and 42° in the descending current.

The inferior specific gravity of the heated air is, in fact, the cause of its ascent, and consequently of the descent of fresh supplies from the atmosphere at a lower temperature; so that it

it is clear that the air which circulates in mines tends to diminish, and not to augment their temperature. The air supplied by mechanical means is comparatively trifling; this mode of ventilation being resorted to only, when, from a deficiency of shafts, the circulation is very imperfect; and as it must ultimately form a part of the warm ascending currents, it is unnecessary to consider its effect on temperature as a distinct question.

True it is, that the ratio of increase is by no means uniform in the mines; nor ought it to be expected to be so, as there are many disturbing causes which must affect the temperature very differently in different places. Of these, the copious filtration of water into the deepest excavations of mines, is, I conceive, the most influential, subject as it is in a peculiar degree to be modified by local circumstances both in its quantity and direction. It cannot however be doubted that it must chiefly come from more elevated ground; and therefore I think it may be inferred, that the temperature of mines is not equal to that of the earth at the same level, either in degree or in uniformity.

The temperature of water in the shafts of abandoned mines has been repeatedly referred to in opposition to the opinion that a native heat exists in the earth itself. On this subject I have made some observations in a paper published, in 1827, in the third volume of the Cornwall Geological Society's Transactions, which I may perhaps be allowed to quote.

"My impression is, that the experiments which have been made in these collections of water tend to support the opinions" (in favour of a subterranean heat), "the differences of temperature being considerable in different stopped mines; and even in different shafts of the same mine a variation of temperature has been observed.

"Some very shallow mines, it seems, have been found full of water to the adit-level at the temperature of 51°; others, at from 52° to 56°, and even 57°, as was the case at Gunnis Lake copper mine, the depth of which was 125 fathoms, and the adit 35 fathoms, from the surface; so that, taking the mean temperature of the climate at as high as 51°, (which, from some experiments to be mentioned*, I now think is rather above the mark, as it respects our principal mining districts

* A series of observations, continued throughout the year, made on the temperature of the ground, and three feet under the surface, gave for Dolcoath 49°·94; and Huel Gorland, which is more elevated, being about 350 feet above the sea-level, 48°·99.

stricts at least,) it gives an excess of five or six degrees for the whole of the water in some shafts, which is equal to ten or twelve degrees for the extreme, even supposing equal quantities of water to flow into the shafts from the higher and lower galleries: this, however, I imagine to be by no means the case, but that by far the largest portion of what is emptied into the adits from the overflow of the waters in shafts *, must be derived from the upper levels and workings of mines. The levels are usually driven on the veins at intervals of ten fathoms under the adits; the superior ones being more extended in length than the inferior; so that they are likely to intercept most of the waters coming from the ground above; and the water following that course which opposes the least resistance may be supposed to pass principally through the uppermost levels into the shafts, and to sink therein, if its relative temperature be low. Thus it may be presumed that the comparatively stationary water in the deeper levels, has but little influence on that in the shafts; for it is well known that this fluid conducts heat in a lateral direction very slowly.

"The effects above mentioned are doubtless variously modified in different places by the nature and thickness of the strata and the more or less pervious state of the veins: besides, the workings communicating with the shafts are in some mines much more open and excavated than in others. And considering all these circumstances, we might, I think, anticipate that the results of experiments on the temperature of water in stopped mines must be discordant and inconclusive as to the actual heat of the earth itself, however strongly they may corroborate the truth of its existence."

I might have added, that there are usually several shafts in mines not carried down through the adit, which must receive large supplies of rain-water from the surface; and this water having, it may be presumed, a mean temperature less than that of the climate, of course tends to diminish the temperature of the water in abandoned mines.

The experiments made to ascertain the temperature of the ocean at great depths are, I think, quite inconclusive with respect to the subject under consideration. The bed of the sea is doubtless composed of very imperfect conductors of heat; but if it were all of solid rock, it would surely be incapable of transmitting heat to the water so fast as the latter would convey it away, not only from its natural tendency, when heated, to ascend in colder portions of that fluid, but also from the

* The quantity of the waters so discharged from the shafts, is generally considerable.

incessant agitation of the ocean produced by currents and tides, &c. For these reasons, it appears to me that a low temperature at the bottom of the sea is not at all inconsistent with a high degree of terrestrial heat.

The temperature about the poles of the earth must also be governed by the relative impressions of the heat and cold to which they may be exposed; and if frost and snow are found on Hecla and other volcanic mountains and districts, owing to the very slowly and imperfectly conducting medium of the rocks and the ground, surely the effects produced by the cold in the polar regions cannot be deemed incompatible with an elevated temperature under the surface. The zones of equal temperatures at accessible depths in the earth having been found to conform, in some degree, to the irregularities of its surface,—this fact affords another instance that whilst the internal parts of mountains and hills may be sustained at a high temperature, their sides and even the valleys which separate them may be quite cold. This arrangement of the zones of heat must, I conceive, cause the water or moisture in the interior of mountains and hills to give out vapour more or less copiously, according to circumstances; and this ascending towards their summits and sides, gradually condenses into drops in proportion as the temperature of the ground diminishes. The drops accumulating into small streams, ultimately appear, in part at least, at the surface, and form a more or less considerable proportion of springs or fountains.

If the terrestrial temperature could be determined with certainty at any given depths within our reach, I much question whether it ought to be considered as furnishing us with proper data for calculating the ratio of increase to a far greater depth, because it appears to me to be highly probable that in the former case the heat may be due to the ascending portions of warm water, more than to the conducting power of the rocks; and this idea derives confirmation from the fact, that those rocks which most readily transmit heat (compact granite for example) are usually found at a lower temperature in mines than clay-slate and other rocks which are the most pervious to moisture and the worst conductors of heat.

It must however be acknowledged that whether the terrestrial heat increases more or less rapidly towards the centre, the frequent occurrence of volcanos and hot springs, in districts far separated from each other, tends strongly to confirm the opinion that a very high temperature exists in the interior of the globe.

ROBERT W. FOX.

Falmouth, Jan. 13, 1831.

XVIII. *On*

XVIII. *On the Stability of the Solar System.* *By* J. W. Lubbock, *Esq. F.R.S.**

THE following passage occurs in the 103rd Number of the Edinburgh Review, p. 43, lately published. "The earth is one of eleven planets which revolve round the sun. It has been demonstrated by mathematicians, that all the little irregularities arising from the mutual actions of the planets on each other run through regular periods, and then vanish. So that their motions, for anything which we know to the contrary, may continue for ever, without any real alterations in the mutual distances between the sun and planets."

The proof of this proposition, as here stated in its utmost generality, is not to be found in any work on physical astronomy; nor is it true, unless the planets move in a medium absolutely devoid of any resistance. The proof given by M. de Pontécoulant, *Théorie Anal. du Système du Monde*, vol. i. p. 455, extends only to the square of the disturbing force. In rigour, however, it matters not at what stage of the approximation the terms come in which create a derangement; the effect might be more slow, but would not be less certain.

In a paper recently published in the Philosophical Transactions, I have endeavoured to overcome this difficulty by the following very simple considerations.

By the first approximation, or that which takes into account the first power of the disturbing force, supposing the body to move in a medium devoid of resistance,

Semi-major axis
Eccentricity
Inclination of the orbit to a fixed plane

} = Series of cosines without a quantity multiplied by the time.

Longitude of the perihelion
Longitude of the epoch
Longitude of the node

} = Series of sines + a quantity multiplied by the time.

The arguments under the sign sine and cosine in these expressions are multiples of angles depending on the mean motions of the bodies which compose the system.

A second approximation may be obtained by integrating the differential equations for the variations of the elliptic constants, after having substituted in the disturbing function their values found by the first approximation. But the values thus found for them by the second approximation retain the *same form* as before: the same is true for the next approximation; and

* Communicated by the Author.

and indeed however far the approximation be carried. So that the following theorem is true, without neglecting any powers of the eccentricities or inclinations, or any powers of the disturbing forces:

$$\left.\begin{array}{l}\text{Semi-major axis}\\ \text{Eccentricity}\\ \text{Inclination of the orbit to a}\\ \quad\text{fixed plane}\end{array}\right\} = \begin{array}{l}\text{Series of cosines without}\\ \text{any quantity multiplied}\\ \text{by the time.}\end{array}$$

$$\left.\begin{array}{l}\text{Longitude of the perihelion}\\ \text{Longitude of the epoch}\\ \text{Longitude of the node}\end{array}\right\} = \begin{array}{l}\text{Series of sines + a quan-}\\ \text{tity multiplied by the time.}\end{array}$$

The series of cosines being a periodic function, it follows that however long the periods of some of the inequalities may be, the semi-major axis, the eccentricity, and the inclination to a fixed plane vary periodically within limits which depend upon the magnitude of the disturbing forces, that is, upon the magnitude of the mass of the primary compared with the masses of the planets, and upon their mean distances from the primary, &c. The other three constants have a term varying with the time; but this, from the nature of these constants, does not affect the stability of the system.

The contrary obtains when the body moves in a medium which resists according to any power of the velocity, in this case, considering only the terms which depend on the resistance of the medium;

$$\left.\begin{array}{l}\text{Semi-major axis}\\ \text{Eccentricity}\end{array}\right\} = \begin{array}{l}\text{Series of sines + a quantity}\\ \text{multiplied by the time.}\end{array}$$

$$\left.\begin{array}{l}\text{Longitude of the perihelion}\\ \text{Longitude of the epoch}\end{array}\right\} = \begin{array}{l}\text{Series of cosines without}\\ \text{any quantity multiplied by}\\ \text{the time.}\end{array}$$

I have also extended these results to the problem of the rotation of the earth about its centre of gravity. The solution of this problem contains six constants: which constants are analogous to those which occur in the determination of a planet's motion round the sun, an analogy first, I believe, pointed out by M. Poisson.

By integrating the expressions for the variations of these constants,

$$\left.\begin{array}{l}\text{The mean motion of rotation,}\\ \text{The cosine of the geographical}\\ \quad\text{latitude of the axis of instan-}\\ \quad\text{taneous rotation,}\\ \text{The obliquity of the ecliptic,}\end{array}\right\} = \begin{array}{l}\text{A periodic function with-}\\ \text{out any quantity multi-}\\ \text{plied by the time.}\end{array}$$

The

$$\left.\begin{array}{l}\text{The geographical longitude of the pole of instantaneous rotation,}\\ \text{The longitude of a given line in the body,}\\ \text{The longitude of a fixed line in the ecliptic, reckoned from the first point of Aries,}\end{array}\right\} = \text{A periodic function} + \text{a quantity multiplied by the time.}$$

Thus the geographical latitude of the pole of the axis of instantaneous rotation, the angular velocity of rotation, and the obliquity of the ecliptic vary eternally within limits which in fact are extremely narrow, and thus the stability of the system is preserved.

I have only shown these results to be true when the earth is supposed to revolve in a medium absolutely devoid of all resistance and friction. It seems worthy of inquiry how they become modified when some degree of friction is supposed to exist.

XIX. *Remarks on the Origin of Rock-basins; in reply to a Paper by Mr.* E. W. Brayley, *Jun.** *By the Rev.* Thomas Moore.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

An article on the subject of rock-basins, by Mr. Brayley jun., —extracted from his contribution, on the subject of Geology, to "The History and Topography of Devonshire," a work now in the course of publication,—having been inserted, with some slight alterations, in the Philosophical Magazine for November 1830, a place for some remarks in reply to his objections to the artificial origin of those cavities, is now requested.

Mr. Brayley commences his observations in the work just mentioned (page 288, 8vo edit.) by saying, "The writer of these outlines might be considered as liable to a charge of inattention to his friend the Rev. T. Moore, author of the topographical and principal part of this work, were he to omit noticing the remarks on the origin of rock-basins contained in the first chapter of Book II." &c. The present writer, however, must take the liberty of observing, that, valuable as

* See Phil. Mag. and Annals, N. S. vol. viii. p. 331.

Mr.

Mr. Brayley's communication may be, he should have been more gratified by "the breach than the observance" of this instance of civility; not because he had any aversion to his opinion on the origin of rock-basins undergoing the test of investigation, but because it was obviously improper to render a work on topography the vehicle of controversy by the writers of it; and also, as he never meant to lay any stress on his own opinion on that subject, he did not wish it to be made a prominent subject in the above-mentioned work; nor moreover had he any intention of arguing the question fully in the slight notice which he had taken of it there. However, as Mr. Brayley has endeavoured to show the futility of this opinion at considerable length, some sort of reply seems to be necessary, and the following remarks are therefore respectfully submitted to the candour of the reader who may feel interested in the subject.

Since the article alluded to has been published, an intelligent and highly respectable correspondent in Devonshire, who is said to be excelled by none in an acquaintance with the antiquities and other curiosities of Dartmoor, has favoured the writer with the following observations, which he begs leave to insert as corresponding with what was suggested to his own mind by the little which he himself saw, and by all that he heard of the rock-basins in this district. "Respecting rock-basins much diversity of opinion has existed; but whoever will inspect them must be convinced of their *artificial* origin. To all appearance they have a connection with other relics found in their neighbourhood; for it may be remarked, that these rock-basins are generally situated on tors which overlook or border on the remains of the ancient British villages on the moor. They are also very distinguishable from the hollows worn by the effects of weather, these basins being often of very regular figure, and cut in the hardest rocks, where no other derangement of the surface is visible."

On the opposite side of the question, Dr. MacCulloch, as quoted by Mr. Brayley, has observed, "The true origin of rock-basins is easily traced by inspecting the rocks themselves, where they are found." Such is the opinion of my correspondent just quoted; but that correspondent was also convinced that such inspection would necessarily lead to a conclusion directly opposed to Dr. MacCulloch's. And the only proof which this distinguished writer has adduced as furnished by the appearance of the rocks is the following: "On examining the excavations they will always be found to

to contain distinct grains of quartz and fragments of other constituent parts of granite;" but he adds, "in time the accumulated gravel is blown away by the winds, although in the deeper hollows it may often be found forming considerable accumulations." In the first place, I very much doubt whether it be really a fact that gravel of this description is always found in these excavations, and indeed Dr. MacCulloch's own remark seems to imply that it is not; for why does he observe that in time the accumulated gravel is blown away, if it were always found there? But let us suppose the statement to be correct, and in many of them such gravel or sand, it will readily be admitted, is found; then, I observe, these particles of gravel or sand may as readily be supposed to have been swept into the basins by the wind, as blown out of them, and to have found a lodgement there: nor will any one think this circumstance extraordinary, who has any knowledge of the violence of the winds in this district.

Dr. MacCulloch proceeds to observe, that "the circumstances which occasion the formation of rock-basins are the presence of water, and the alternate action of air and water. If a drop of water can make an effectual lodgement on a surface of granite, a small cavity is sooner or later produced. This insensibly enlarges as it becomes capable of holding more water, and the sides, as they continue to waste, necessarily retain an even and rounded concavity, on account of the uniform texture of the granite." Now we have no doubt that a continued stream of water, especially if it flow with rapidity, will wear itself a channel, and create hollows in the hardest rock; and the Rev. J. P. Jones, the distinguished Botanist of Devonshire, in his account of one of his tours on Dartmoor, mentions a remarkable fact of this kind very much to our present purpose. He states, that in crossing the streams on the Moor, he observed, not only many small cataracts, but basins in the rocks on the borders of the currents; and that these curious cavities, however, were never formed unless the rapidity of the stream, meeting with some obstructions, formed an eddy. Here then is the operation of natural causes fully adequate to the effect produced. A body of water perpetually whirling round with considerable velocity, and carrying with it, no doubt, gravel and stones, has insensibly, through a long succession of ages, scooped out these rock-basins: but that a drop of water, having found a lodgement on the horizontal surface of the hardest granite, should, by chemical operation, make any serious impression there, and that hence by the gradual accumulation of water rock-basins should be formed on

on these flat surfaces, some of which, as Dr. MacCulloch observes, "are as regularly spheroidal internally as if they had been shaped by a turning lathe," and it may be added some of which also are several feet in diameter*,—to the reception of this proposition my power of credence, I confess, is not equal. I see here, indeed, a theory supported by a distinguished name, but by no sufficient proof. Mr. Brayley himself states a fact in direct hostility to this hypothesis. There are granite beds, it seems, which present basins on their perpendicular faces ("Devon," p. 292—294); and water might indeed be arrested there by a miracle, but if it followed the course which nature requires, it would certainly descend, and leave the rock as before. Some other cause therefore must necessarily be sought for, to account for the production of these basins at least.

But if we are to suppose that rock-basins can be formed by "the presence of water, and the alternate action of air and water," and if, as Mr. Brayley affirms, "we need not hesitate in admitting the solution of granite in water to an extent capable of producing this effect of disintegration," then I ask, in what state ought we to find the granite in the beds, or rather at the sides of the rivers near the surface of the water, where it must be constantly exposed to the alternate and powerful action of air and water? Worn indeed it may be by the current, together with the sand and stones which the water carries along with it; but that it is corroded chemically, and that to a great degree, in conformity with Dr. MacCulloch's theory, by the operation of both these elements, does not appear to be the fact†.

Again: if cavities can be formed in the rock in the manner Dr. MacCulloch supposes, then I maintain, the whole of the horizontal surface of the rocks would be corroded, and would be generally as full of hollows as a honeycomb, though with nothing of the regularity of the latter, for a drop of water would easily find a lodgement in numerous places. This however is not the case on any of the rocks in Devonshire; on

* Borlase states the diameter of some of them to be six feet.

† A valuable correspondent of Plymouth, who has much information on these subjects, after expressing his concurrence with the brief remarks in defence of the artificial origin of rock-basins which gave occasion to Mr. Brayley's discussion of the subject, observes, "There may be instances in which Dr. MacCulloch's theory is verified, but I have never found moorstone decomposing under the drip of water; and why are the rock-basins so often upon the highest ridge of these stones, if they be not artificial?"

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the contrary, as my correspondent before quoted observes, "the basins are not only often of very regular figure, but are cut in the hardest rocks, where no other derangement of the surface is visible. And they are also very distinguishable from the hollows worn in the softer parts of some rocks by the effects of weather." These cavities are not only, as Dr. MacCulloch states, occasionally circular in their boundary, and as regularly spheroidal internally as if they had been shaped in a turning lathe, but their sides also are smooth and even; and these circumstances appear to me to be decisive of the question. Dr. MacCulloch, it is true, ascribes this regularity of form to "the uniform texture of the granite." Now the constituent parts of the granite which most generally prevails in Devonshire, are stated to be quartz, felspar and mica; and we are told that these several materials are of different degrees of hardness. Mr. Brayley has spoken of "the felspar of the base as dull, earthy and decomposing" ("Devon," p. 251), and of another of the decomponent parts as "almost indestructible." This being the case, then, I maintain that the decomposition, which is admitted to be going on at present as heretofore, would necessarily follow the softer particles of the rock; and the consequence would be, that the figure of the cavities in question would become, in all cases, irregular, and bear little or no resemblance to the rock-basins as they now are, and as Dr. MacCulloch describes them. And not only would they be irregular in their form, but the surface of these cavities would also be rough and crumbly, the "soft, earthy part having decayed," and left the "indestructible" portions projecting. But this is not the fact; and Mr. Brayley has accordingly admitted ("Devon," p. 290) that in his examinations of the rock-basins on the summit of Carnbrea Hill, near Redruth in Cornwall, "he did not find the sides of the basins crumbly." The inference appears to me to be obvious and conclusive:—the sides of the basins *ought* to be rough and crumbly, if formed as Dr. MacCulloch represents, and if the constituent parts of granite, as is also affirmed, are of different degrees of hardness or durability; but they are *not* rough and crumbly, and therefore not formed by the only natural process to which their formation is attributed.

What Mr. Brayley however considers as the strongest evidence of the artificial origin of these cavities, but which, notwithstanding, has escaped Dr. MacCulloch's notice, is as follows:—"Many of the rock-basins on Carnbrea are crossed by veins of porphyry or porphyritic granite, which traverse the carns, and which, offering a much greater resistance to the action of decomposing agents than the granite itself, have

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been left in the form of ridges, their edges only having been rounded by the action of the elements. This fact is obviously conclusive," &c. Not having seen these cavities, I shall not venture to give any opinion decidedly respecting them. From Mr. Brayley's description of them they appear to be very irregular, and if he had not said that he did not find their sides crumbly, I should be disposed to consider them as belonging to that class of excavations which have been formed by natural causes. If their origin were artificial, it is possible the ridges might have been left through want of sufficient skill to remove them; or, the softer parts of the rock may perhaps have been since worn away by the action of the weather, leaving the porphyry projecting. But at any rate the reasoning from these does not appear to me to apply to the rock-basins in Devonshire, where, though the component parts of the granite are said to differ greatly in durability, no projections occur. From the former of these instances therefore no serious objection appears to arise to the artificial origin of the latter.

Mr. Brayley, indeed, has himself felt a difficulty on this subject; for admitting the insufficiency of Dr. MacCulloch's theory, he has proposed another objection to it, by saying ("Devon," p. 292), "And indeed it would appear that some further cause than the uniform texture of the granite must in reality operate in the formation of these basins; for if that only were the reason, the granite would be as much acted upon in a direction perpendicular to its surface, as in those directions which are parallel to it; and the depth of the basins ought always to be equal to their diameters, or nearly so; which, as far as the writer's knowledge extends, is seldom, if ever, the case. And the occurrence of the rock-basins on the vertical faces of the granite at Scilly would seem to be a further corroboration of this idea; for it is difficult to conceive how the action of water could produce such cavities in this situation, unless it were aided by the tendency of the rock to disintegrate more easily in certain directions, with respect to the planes of its surfaces, than in others." The reasonableness of these remarks is sufficiently obvious; and the further cause than the uniform texture of the granite necessary to the production of rock-basins, Mr. Brayley supposes to be found in the spheroidal structure of this rock. His reasoning appears to be thus:—The constituent parts of granite are spherically arranged; in other words, a mass of granite consists of a number of spheres; and as disintegration on the flat surface of the rock takes place, this kind of structure is favourable, in some way or other, to the formation of these cavities: and that the structure of granite is thus spheroidal in all cases, Mr.

Mr. Brayley is of opinion that Dr. MacCulloch has rendered in the highest degree probable. To me however, I must take the liberty of saying, the proofs adduced are not by any means so satisfactory as Mr. Brayley supposes them to be. Some kinds of rocks, and even some rare specimens of particular sorts of granite, may be unquestionably spheroidal; but to infer hence that all granite is so, would surely be much too hasty, and can scarcely be satisfactory even to those who have a favourite notion to support. But that the structure of the Devonshire granite is not of this kind appears evident from the following considerations. In the first place, if it were so, this ought to be apparent on inspecting it. The crystals, for instance, are usually large and very distinct; but have they any appearance of a concentric or spherical arrangement? Certainly not: they seem to be thrown together in confusion, and have in general no regular arrangement whatever.

Again, the direction of the fissures in this granite are clearly adverse to the supposition of its spheroidal construction. Masses of this rock are divided into cuboidal or laminar blocks, bounded by fissures horizontal, perpendicular, or inclined, often "mere mathematical planes and preserving an exact parallelism among themselves;" whereas, if the constituent parts of the granite had a spherical arrangement, these blocks surely ought to be spheroids, and the fissures of a circular form. They would separate like the coats of an onion, "whether the fissures, as originally existing in the granite, are to be considered as the effects of contraction produced in the mass by the evaporation of water, or by the abstraction of heat." Much is said, it is true, about the boulders of this rock, and the rounded form of the edges and corners of the blocks and the laminæ. To this it may be replied, that all the projections of the granite, the corners, and the edges, are most worn because they are most exposed to the action of the atmosphere, to which their decomposition is attributed, and that this would be the case, whether there were anything spherical in the arrangement of their constituent parts, or not; so that no argument in favour of such arrangement can be derived from this circumstance, of sufficient weight to decide the question. Proof therefore being wanting of the spheroidal structure of this granite, all reasoning from it in favour of the formation of rock-basins by a natural process, falls to the ground*.

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* Mr. Brayley has mentioned the Logan on the Teign in connection with this subject, and has taken it for granted that its form is spheroidal. But his account of it is in the main particulars erroneous. Having taken a slight sketch of it myself, on the spot, I can speak of it without hesitation. It is not properly seated, as he observes, "in the channel of the river," but

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On the whole, therefore, I am still inclined, for the reasons now adduced, to retain my original opinion, that the rock-basins properly so called, and distinguished from other irregular cavities in the rocks, are artificial. At the same time I am not disposed to lay any undue stress on this opinion, and have undertaken the defence of it with reluctance. One or two other facts, however, in support of it, may be added. The rock-basins in Devonshire," Mr. Burt*, who was well acquainted with Dartmoor, has observed, " are always on the verge of the rock." What reason can be assigned for this, if these cavities are the result of the chemical operation of the elements? Does not such a position indicate some design in their formation? They are also comparatively few in number, for among the numberless rocks and tors on Dartmoor by far the greater part are without this distinction: and why should not rock-basins be found upon rocks and tors of the same texture generally, if formed by some natural process by which all are liable to be affected? They are, moreover, sometimes found singly, where there is no other derangement of the surface; and generally in the vicinity of other British remains. Cornwall, which abounds most with the latter, exhibits also, it seems, the greatest number of the former. All these circumstances serve to strengthen the belief of the artificial origin of these singular cavities. Nor is there any evidence, from time immemorial, of their increase either in size or number.

At the same time, I am contending only that their origin is artificial. By whom or for what purpose they were formed is not known; nor is it my intention to hazard any conjecture on the subject. They are of two kinds; one, simple cavities

at the side of it, at the foot of a steep hill, the side of which is covered with blocks of granite of different sizes, and has every appearance of having rolled or slidden down the declivity with many other blocks, which lie on the banks and in the bed of the river, and of having rested and poised itself upon a slight elevation of a low rock beneath. Or if this were not the case, the fissure between itself and the rock on which it rests may have been worn larger than it was originally by the current, which is here very rapid, leaving a fulcrum near the centre on which it moves. It is now moved with difficulty, and could never have oscillated more than an inch or two. Its form moreover does not approximate to the spheroidal. I have seen in some publication, the title of which I do not now recollect, what was intended for a view of it, and in that view the form, indeed, that was given to it, was spheroidal: but it is no more like the real Logan than an apple to a cube. The true form of it is intended to be given in a future number of " The History and Topography of Devonshire," and a near resemblance to it may be now seen with the ornamented letter at the beginning of Book II. of that work.

* Notes to Carrington's " Dartmoor," p. 196.

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cut in the surface of the rock; the other, with lips, or communications between the different basins, in some instances one of them being lower than the other, and the communication between the two sometimes extending to the bottom of the upper basin. Borlase*, who was the first writer, I believe, that made any attempt to account for the origin and design of these cavities, rejects the notion that they were used for libations of blood, wine, honey, or oil, and thinks they were intended to collect water from the rains or dews, in the greatest purity, for the purpose of ablutions, which were very common among the priests of all ancient superstitions, and probably therefore among the Druids. But he proposes this of course only as conjecture.

That the ancient Britons were capable of forming them, there can be little doubt. We know that they had made at least some progress in the mechanical arts. We learn, for instance, from Cæsar, who could not be mistaken, that they had chariots of war, armed with scythes, and there is other evidence of their possessing skill equal to the task in question. The Phœnicians, moreover, had made much greater progress in mechanical skill; nor is it disputed that with the West of England especially they had much commercial intercourse, and there is some evidence of their having formed settlements here as they had done elsewhere. This being the case, they could scarcely have failed to communicate some portion of their own improvements to the Britons. What is there extraordinary in the supposition that these rock-basins might possibly be formed by these ancient inhabitants of the island? And if conjectures are to be hazarded, the most probable seems to connect them with Druidical superstitions.

I cannot conclude without taking notice of one observation more of Mr. B.'s ("Devon," p. 289): he has found, he says, "other antiquarian friends are not willing to resign altogether that notion of these excavations, which in the hands of Dr. Borlase and his compeers has given rise to so imposing a pageant of the ceremonies of Druidism." I at least have not met with any writers who are at all disposed to rest their opinions on so slight a foundation. Their notions of Druidical ceremonies are usually derived from ancient writers, who were best acquainted with these matters, and are most worthy of credit. In the account which I have given of these superstitions in the early part of the work on Devonshire, I have made very little use of Borlase's work; for I am aware that this writer appears to have been in the habit of bringing together statements favourable to his own notions, from various

* p. 230 of his work on the antiquities of Cornwall.

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rious sources, without sufficient examination into their value and authenticity. Not considering him therefore a guide that could be always followed with safety, I have referred to other and higher authorities. At the same time I am far from thinking this writer to be deserving of contempt. His learning and the general extent of his researches entitle his opinions to attention. I must also be permitted to add, that I have not rested the proof of the existence of Druidism in the West of England on the existence of rock-basins, or on any other British remains in this district, but on the consideration, that as this superstition constituted the religion of the ancient inhabitants of this island, it was matter of course that it prevailed also in the West, and retained its hold longer there than elsewhere in England, as this was the last quarter from which the Britons were driven, or in which they were reduced to subjection. The British remains in Devonshire and Cornwall may, or may not, be connected with this ancient superstition; but the probability appears evidently to be that they were.

After observing justly ("Devon," p. 281) that every natural phænomenon and production that was not understood, was in early times generally attributed to supernatural agency, Mr. B. proceeds to remark, that "in modern times, natural phænomena of the same description, which the existing state of science has not afforded the means of explaining, have been regarded as the works of ancient nations, and, in this country especially, as those of the Druids, or at least of the people whose operations were instigated or directed by them." And no doubt much error has arisen from this source: but it may be well to recollect that it is possible to run into the opposite extreme, and in the eagerness to stand as far aloof as possible from the prejudices of ignorance and folly, credulity may still be discovered in ascribing to the agency of nature the results of human art and industry. In our efforts to assign natural causes for extraordinary productions, we must be stopped somewhere by reason and common sense, or in the future and accelerated progress of the sciences we shall doubtless at length find out, not only that the rock-basins, but the cromlechs, and what are vulgarly supposed to be Druidical circles, as Stonehenge for instance, are positively natural phænomena. In these latter productions I discover marks of human agency and design, and therefore ascribe them to these causes; and for similar reasons I am still inclined to believe that rock-basins are artificial.

Islington, Jan. 3, 1831. THOMAS MOORE.

XX. *An*

XX. *An Examination of those Phænomena of Geology, which seem to bear most directly on theoretical Speculations. By the Rev.* W. D. Conybeare, *M.A. F.R.S. F.G.S. &c.*

[Continued from page 23.]

VIII. THE distribution of the rocks usually considered as of volcanic origin, in the different formations, is such as to indicate the greater prevalence of volcanic agency during the earlier periods; and the relations of the actual volcanic vents are such as to prove that these are only the residual portion of a much larger number which have coexisted in the antecedent epochs.

Observations.—This article ought strictly to have occupied an earlier place in my arrangement, and to have immediately followed No. IV. but as it will be seen that many causes tend to throw obscurity on this part of our subject, and to prevent our arriving at more than approximate results, I have judged this departure from a more exact method justifiable, as I have thus been enabled to give precedence to the evidence which appeared to me most clear and satisfactory. From the intrusive position of these rocks, which appear very frequently to have been injected among the strata which they traverse, subsequently to the deposition of those strata, a difficulty arises, *in limine*, as to the determination of their age. We know them to be subsequent to the beds traversed; but who shall say how much so? In order to ascertain this point, the junction of these beds with the succeeding formations should be carefully examined, and the exact geological point noted where these intruding masses are cut off and cease to traverse those formations. For instance, if a trap dyke shall be found traversing the coal measures, but cut off by the incumbent magnesian limestone, we may then be sure that the cause which produced this dyke was in action before the deposition of the magnesian limestone. We have, however, hitherto few observations to this effect; but it yet seems to me that an approximation is attainable; for we find that the rocks usually considered as igneous, materially vary in their characters in the different formations; granite occurring most generally in association with the rocks termed primitive; peculiar greenstones and porphyries with those of transition; others again with some varieties of basalt in the coal formation. Now whenever we find peculiar varieties always associated with a single formation, and excluded from the contiguous formations of more recent date, we may fairly, I think, infer that their production has taken place almost contemporaneously with that of the formations in which they so occur; yet it must be owned that the

the different varieties of trap pass into each other by such insensible gradations, that much doubt must often hang over the subject.

In the so called primitive epoch, we find a very large proportion, universally distributed, of rocks which have been referred to an igneous origin by evidence which has produced an increasing effect on the minds of geologists, the more attentively it has been examined and weighed. I speak principally of the granitic rocks; but I think we must refer most of the felspathic and amphibolic series to this class. From their general relations, we may probably consider most of these rocks as having originated antecedently to the transition period; but I am far from supposing that any of them are necessarily confined to this age; on the contrary, I believe many granitic rocks, those especially passing into sienite, to belong generally to the transition period, and some to even younger epochs*.

The transition period likewise embraces a very large proportion of rocks, such as greenstones, sienites, &c., apparently of igneous origin; though here again the same difficulty as to limiting their exact age presents itself: for instance, in Pembrokeshire the graywacke is extensively associated with greenstone, which latter, when it approaches the superjacent carboniferous limestone, breaks through it, thus demonstrating its more recent origin. Yet when we take a general view of the primitive and transition districts, and compare the proportion of the rocks generally esteemed of igneous origin, which universally occur associated with them, occupying generally nearly one-fifth of these districts, with the much smaller proportion of the igneous rocks in the more recent formations, and their frequent absence in the latter case, we cannot, I think, resist the conclusion, that the causes which have produced them were in much more active operation in the earlier period.

The carboniferous series still embrace many trap rocks, though in a far less proportion, and much more limited to particular localities. Thus they are very abundant in the Scotch carboniferous tract; less so, but still far from scarce, in that of Northumberland and Durham; that of Derbyshire scarcely exhibits them, except in the toadstones alternating with the limestone. We find them in overlying masses at Cleehill, and in Staffordshire at Dudley; but the great coal basins of our south-western counties, Somerset and South Wales, scarcely

* Boué refers the granite of Zinwald in Bohemia to the transition period, and that of Baveno even to the carboniferous. Near Predazzo there is an upright mass of granitic porphyry, said to be younger than the lias.

present

present a trace of them, excepting in the single point in the west of Pembrokeshire, which has been already mentioned; for the trap of Tortworth in Gloucestershire, though it nearly approaches the Bristol coal-field, yet appears to be limited to the transition group.

In the carboniferous districts our former difficulties again recur in limiting the age of the associated trap. In one instance, the Cleaveland trap dyke (in the north of Yorkshire) traverses not only the coal-measures, but also the incumbent red marl, lias, and inferior oölite. We must however, I think, consider far the greater part of the trap rocks to have been produced before the age of these formations; for how otherwise can we account for the absence of trap in these last, which throughout England is, with this single exception, I believe total. We have here, then, in the carboniferous series, an example of an intermediate group containing much less of volcanic rocks than those which preceded, and much more than those which succeeded.

In the oolitic and other more recent formations of England, I am not acquainted with any instance of the occurrence of any rock of the trap family, excepting only the just-mentioned case of the Cleaveland dyke. On the continent, however, Elie de Beaumont has noticed, associated with the lias in the hill of Chardonnet (Alps of Briançon), a petrosiliceous eurite (compact felspar?), with a little hornblende, in beds of considerable extent. In the Vicentin, at Predazzo, and in the Tyrol, augite porphyry occurs in the lias and oolite. Brongniart refers these rocks to his entritic group, which he considers as occupying a middle place as to age, between the older granites and younger trachytes and basalts in the volcanic series, and ranging from the transition to the older tertiary beds: this he defines as composed of rocks having their parts interspersed with crystals, nodules, and portions confusedly crystallized; it seems to include the rocks more commonly called trap porphyry, compact felspar with hornblende, and several varieties of toadstone (variolite, spilite agatifère, &c.).—See *Tabl. des Terreins*, p. 344.

In the tertiary period, the north of Ireland presents us with an extensive area of basalt reposing on the chalk; the same rock occurs superior to the scaglia of the Vicentin, associated with trachyte. Trachyte and lava, evidently of more recent origin than the tertiary lacustrine deposits, also abound in the volcanic districts of Auvergne, of the South of France, near Montpelier, and Toulon, of the lower Rhine, &c.; and it seems probable that the basalt of Cassel, and even of Saxony, belongs to the same period. Indeed, basalt and trachyte ap-

pear generally to characterize the youngest æra of volcanic action.

Brongniart is also of opinion that the period of activity of the extinct volcanos of Auvergne belonged to the close of the tertiary rather than the commencement of the actual epoch; and believes it to have preceded the action of the causes, whatever they may have been, which produced the vast accumulations of gravel, which he designates "Clysmien," a term which, having the fear of Mr. Lyell before my eyes, I dare not translate 'diluvial' (*Tabl.* p. 364). He admits, however, that any well authenticated example of the lava of those volcanos actually overlying the said gravel, would negative this presumption; but contends that the instances hitherto cited have been only beds of volcanic fragments, which might readily originate in the same causes which produced gravel of the other rocks.

Proceed we now to the volcanic vents which still continue in a state of activity. If we compare the proportion of the surface actually thus occupied with that of one-fifth, which we have seen must have prevailed in the primitive and transition periods, we shall again have a ratio which I can only express as tangent : cotangent of the infinitesimal part of a second, which (as far as I am acquainted) the advocates of existing causes alone consider as that of equality. It might however be objected that this is an unfair view of the case; that in all the earlier formations we have the accumulated products of the volcanic action of many remote successive ages of immense duration; that perhaps but a very small proportion of this total resulted from the volcanos of any one single age; and that the new vents which have in the actual æra succeeded to those now extinct may, therefore, be as numerous as those which previously existed at any single date. But to this we answer, that if the actual sites be examined, far from appearing to be new vents which have replaced extinct old ones, they will be found to be only small residual portions of much more extensive volcanic districts, which appear from the rocks characterizing them, trachyte, basalt, &c., to have been contemporaneous with those of Auvergne, the Rhine, &c. Thus in Iceland, Hecla only is active; but the whole island is obviously the product of ancient volcanos. In Italy, Vesuvius occupies but a small part of the Campi Phlegræi; and there are many other like districts near Rome, about the Alban lake, &c. &c. On this subject I cannot do better than quote the very words of Brongniart, whose authority deserves the more attention, as he has most carefully studied the whole subject, and drawn up one of the most complete

complete accounts of volcanos extant, published in the *Dictionnaire des Sciences Naturelles* :—

"Pour rassembler ici toutes les observations qui concourent à établir LE REPOS ACTUEL des grands phénomènes geologiques, et l'absence de toute formation complète de terrain nouveau, je dois rappeler en abrégé les faits qui dans l'histoire des terrains pyrogènes volcaniques tendent à confirmer cette proposition.

"1. Toutes les bouches volcaniques en activité font partie d'une système volcanique dont l'origine ou l'époque d'apparition à la surface du globe est absolument inconnu. On ne peut citer aucune nouvelle bouche volcanique, aucun nouveau cone ou butte volcanique terrestre, littoral, ou marin, qui ne fasse partie ou ne soit lié avec un système de terrain volcanique ancien." p. 61.—He adds, that the modern lavas are destitute of many rocks and minerals which characterize the ancient, *e. g.* true basalt, trachyte, metallic minerals, &c.; and that the rocks which are produced by aqueous solution, such as the siliceous incrustations of the Geyser, and concretionary limestones in modern volcanic districts, are little varied and of small extent compared with the analogous deposits of the ancient basaltic and trachytic tracts.

I have been the more anxious fairly to state these arguments, because in a very valuable publication, which has appeared at the moment I am writing, by one of our first scientific names (which I had most earnestly hoped to have seen placed, where it undoubtedly ought to have been, at the head of our first scientific Society), I mean Herschel's Discourse on the Study of Natural Philosophy, p. 147,—the author, speaking of the diminution of the temperature of the globe, states that some geologists have ascribed this to the immensely superior activity of former volcanos, which, however, he observes, can hardly be esteemed a *vera causa;* for, says he, "we are not sure that such supposed greater activity of former than of present volcanos really did exist." Now, unless I have entirely failed, I would hope that in my late communications I have shown some grounds for believing that we are as sure of this fact as we can be of any which is not submitted to the evidence of the senses, but requires to be established by a chain of inferential reasoning. Mr. H. himself inclines to refer this diminution of temperature to the diminution of the excentricity of the earth's orbit. On a subject of this nature I feel myself altogether incompetent to hazard an opinion; and I will therefore only inquire whether, seeing that the mean distance of the earth from the sun is necessarily a constant invariable amid all the oscillations of the system, the proposed

secular variation be fully adequate to account for the phænomena.

[To be continued.]

P.S. I most reluctantly enter into anything which may resemble a personal controversy with Mr. Lyell; and therefore regret that, in a note to one of my communications, I may seem to have provoked it; but it is best, perhaps, frankly to state the case. On comparing his second chapter with the passage referred to in my Outlines, I did not doubt that it had been immediately suggested from that source, and I felt, foolishly perhaps, hurt at the absence of acknowledgement. All the passages perhaps may have been quoted by others before in scattered parts of different works;—but that they had been brought together expressly with the purpose of illustrating the attention which the ancients had given to geological phænomena, before I, and subsequently Mr. Lyell, had so collected them, I am still ignorant. That I am not desirous to claim originality for second-hand quotations, will, I think, sufficiently appear from the note in my Outlines referred to, where I have expressly acknowledged my obligations to Prichard's Egyptian Mythology, instead of citing directly the passages from Lipsius and Censorinus, which I might readily have done. It was in fact our common citations from Prichard's work which most strongly persuaded me that Mr. Lyell had copied from me. That two independent authors should apply exactly in the same manner, and in the same connection, to geological subjects, the same extracts from a work on a subject by no means of universal interest, and altogether alien to geology (the argument of Prichard relating entirely to mythological cosmogony), appeared to me extremely improbable; and I think those who examine the phænomena of the case cannot consider my suspicion unnatural. At the same time if Mr. Lyell will state in express words (which he does not appear to me to have done in his late notice) that the coincidence was really accidental, I shall be most happy to apologize for having used the expression ironically; on the other hand, if he was in any degree led to the materials of his chapter from my previous statements, I trust he will feel that an acknowledgement would have been more friendly.

There are only two points incidentally introduced on which I have to observe: first, with regard to my quotation from Strabo. I am inexpressibly surprised that Mr. Lyell should consider it as altogether unconnected with the passage to which he has referred. Strabo concludes the general argument, which Mr. Lyell has so ably condensed, by alleging certain

certain examples to illustrate and confirm his views. "In order," says he, "to render less wonderful and incredible the revolutions which we have just stated to be the causes of the deluges and the like catastrophes which have been mentioned at the Lipari Islands, &c., it is worth while to produce for comparison yet more examples of the like nature which exist or have happened in other places." Strabo, vol. i. p. 83, 84. ed. Ox. One of the first examples thus introduced (at the top of the very next page) is the case of the volcanic elevation of the country about Methone, which I have myself quoted: under these circumstances, it certainly appears to me perfectly impossible for any one to have carefully verified my quotation, in the connection in which it stands, without being necessarily conducted to the general argument abridged by Mr. Lyell, of which as an illustration it certainly does form an essential part. I should have been quite at a loss to conceive how I could myself, as I have done, make this singular omission, did not Mr. Lyell now suggest a cause, by showing that the passage had been before quoted by Raspe; from whom, therefore, I candidly confess that I now suppose I must have taken it at second-hand, without even the trouble of verification. All I remember is, that I copied the reference from a note in my common-place book. My carelessness has been rightly corrected, by occasioning me to overlook by far the most important passage in the whole range of classical antiquity, with reference to geology;—a passage which has been now so ably put forward by Mr. Lyell, from whose merit I willingly confess it will little detract, whether or no he may have been originally led to it in the process of verifying Raspe's or my previous quotation.

The last observation I have to make is on Mr. Lyell's remark, that I have represented the ancients as proceeding in the *priori* road rather than by induction; which is grounded, I believe, on my having given an example in which Aristotle certainly has done so.

XXI. *On the tidelike Wave of Lake Ontario.* By Samuel Sharpe, *Esq. F.G.S.**

IN a late Number of the Philosophical Magazine is a paper by Dr. Bigsby, on the Lake Ontario, in which he slightly mentions the tidelike wave on the lake, but only in such a manner as to make us wish for further information.

* Communicated by the Author.

The

The observations he records are:

1st, Observed by Mr. Gourlay; at the Whirpool there was a tide of three feet every four or five minutes.

2ndly, by Dr. Bigsby; a mile below the Whirlpool there was a flux and reflux of a foot every three or four minutes.

3rdly, by Mr. Gourlay, confirmed by Dr. Bigsby; at Queenston Wharf, on the river Niagara, there was a constant ebbing and flowing of one foot in a minute.

4thly, Related by Mr. Gourlay on the report of others, that the tide of Nappanee took fifty minutes to flow and a hundred minutes to ebb.

Now if we suppose these undulations to be caused by the wind, and that like water in a basin, when it is highest on one side it is lowest on the other, the distance from shore to shore will be similar to half the space between the tops of two waves in the ocean, and having the distance given, we may by comparison with the pendulum learn the time of undulation.

As the first and second observations were made at different times, though at the same place, the wind had probably been blowing with different force, which accounts for the disagreement in the height to which the waves rose; and might have been blowing in different directions; in one case more along the lake, and in the other more across it, which might account for the difference of the time.

Let us compare these two observations with the theory, neglecting the last two, which were made at different places; the third being on the river, which will account for the shorter intervals between the flux and reflux; and as there is no obvious reason for the longer period of the fourth observation, we may perhaps be allowed to think it less accurate, as being related at third hand.

Making d = the distance from shore to shore,
p = the length of a seconds pendulum 39·11 inches,
t = the time between high- and low-water,
we have by Newton's Princip. II. 46.

$$\frac{d}{2\,p} = t^2$$

and taking d, first = 171· miles the extreme length of the lake, we have $t = 6\frac{2}{10}$ minutes.

And again, d, as a minimum, at the average breadth of the lake, = 35 miles, we have $t = 2\frac{8}{10}$ minutes.

These are the longest and shortest periods that can be allowed for the undulation; and as the first and second observations are within these extremes, they agree as nearly with the theory as can be expected without further details.

These

These remarks are offered with the hope that they may be the means of drawing out more information on the subject from those of your readers who have opportunities of making similar observations either on our own lakes or on those of other countries.

XXII. *Observations relative to the Origin and History of the Bushmen.* *By* Andrew Smith, *M.D. M.W.S. &c.**

THAT the genuine Hottentot, at least in an uncivilized state, will doubtless ere long only be known to us through the pages of history, is a position tenable, upon the rapid decay of the race, its intermixture with other varieties, and the gradual extension of civilized life; all now in active progress, having a strong tendency to produce the state, and hurry on to the period in anticipation. This apparent certainty of the approaching extinction, of at least the savage portion of the race, points out the present as the latest stage calculated for observing and recording information concerning the peculiarities of their character and organization, which nature herself will soon cease to supply, and declares that every, even the most trifling, advance to this point will be something gained for posterity. Under such impressions the following remarks are offered to the notice of the Institution, not so much from their being adapted to supply the numerous wants, as for calling attention to the subject, and eliciting from others the various and requisite details.

The Aborigines of South Africa, under whatever local names they may have passed, or still do pass, according to the special tribes to which they may have belonged or do yet belong, will be found to have consisted, and still to consist, only of two distinct races, namely, those of the Hottentot and Caffer. The first of these, or that which from the circumstances above alluded to has the greatest claim upon our immediate attention, was, and to a certain extent is, even now divided into distinct tribes or hordes; each having its own distinctive appellation, and, more or less, governed by its own laws. Amongst those, one division has always held, and still continues to hold, a most conspicuous position, and has ever been proverbial with the rest, on account of its troublesome character and universally outrageous conduct. To this the other tribes, as well as its own members, apply the name of

* From the South African Quarterly Journal, No. II. page 171.

Saap

Saap or *Saan;* and history describes a portion thereof under the appellation of Bushmen, to which, as a subdivision of the former, the following remarks are intended to apply.

The term Bushman, or more properly Bosjiesman, is of Dutch origin, and commonly employed at present by the colonists to designate a native of the wild and savage tribes residing immediately beyond the northern boundary of the colony, and supporting themselves either by plunder or the spontaneous productions of nature. The time when such communities began to exist must ever remain a matter of conjecture, yet it is certain that they occurred at an early period; for we find that the histories of such hordes are familiar to the better disposed Hottentots even far in advance of the colony, and stated by them to have existed from time immemorial. Considering the manner in which their numbers are at present occasionally increased, we may, without much danger of error, attribute their origin partly to the consequences of war and poverty, and partly to the association of characters whom crime induced to seek a refuge in the desert, or the habits of a better state of society expelled from its haunts. In very early times the part of the country now known to us as the chief resort of the Bushmen was more densely populated than at present, and the outrages and violences perpetrated by its inhabitants were, according to tradition, even more frequent and horrible than they now are. In such days also, the barren districts lying between the Oliphant and Groone Rivers, now a long way within the boundary of the colony, together with various other spots near the western coast, were peopled by such characters; and the Great Karoo, as well as the country about the Camptoes River, were likewise at one period the retreats of persons like those in question. The belief of such having been the case is founded partly upon the traditions of the older Hottentots; partly upon the statements of the writer of the Diary of a Journey made by Governor Simon van der Stell, to the country of the Amaquas*, and partly upon the authority of a document quoted by the Rev. Dr. Philip†, which furnishes evidence, showing that in the year 1702 a party of armed Boors reached as far as the last-named district, and found there "no kraals, except hordes of Bushmen." Besides such

* "Beschryvinge van de Kaap der Goede Hoope, door Francois Valentyn," p. 6, Amsterdam, 1726; or translation in the South African Quarterly Journal, vol. i. p. 39 et seq.

† Researches in South Africa, by the Rev. John Philip, D.D. vol. i. p. 37.

real

real and presumptive proofs of their ancient existence in various situations, we also find them in the present day scattered over all the deserts of Great Namaqualand and the Butchuana country*, and observing there a similar line of conduct towards the Hottentots, Damaras, and Caffers, in their vicinity, that those within reach of the colony do towards its inhabitants. All such have certainly anything but a tendency to support the opinion entertained by not a few, that the tribes in question were originally called into existence through the outrages of the colonists; and though I am ready to admit that very great oppressions have been extended to the natives by the white population, yet it is impossible to allow, with such facts before us, that the latter were in any way instrumental in giving origin to a peculiar community of individuals, which there is every reason to believe existed long before European influence approached even the confines of their country.

Though justice induces me thus to object to such a cause as that assigned, yet at the same time I am quite prepared to admit that the malpractices referred to by the advocates of that opinion, have had doubtless considerable share in augmenting the number,—believing that whatever tends to create poverty, is calculated for producing and likely to produce Bushmen, wherever Hottentots occur. Instead then of ascribing the origin of such to an individual, a recent and a limited cause, I would rather venture to attribute it to influences which operated of old, as well as still continue to operate,—namely, poverty and crime. The former I would regard as having been, and as still being, the most productive; the latter as the most odious and dangerous: the first, as having been, as well as being the consequence of misfortune, but more frequently of imprudence; the last, as now and then the result of accident, but more generally of mental depravity; and both, as having operated and as still operating in many parts of South Africa, in producing and increasing the numbers of the tribes under consideration.

The majority of the Bushmen population, according to the restricted sense in which the term is here to be understood, consists of pure Hottentots; and the remainder of blacks, either the offspring of an intercourse with the former and other coloured persons, or else the actual outcasts of other

* Mr. Anderson, who was some time a Missionary amongst the Corannas, when speaking of a spot near the Orange River, says, "The Coronnas occupied this place; they are by no means so numerous as the Boschesman, who are every where to be found from east to west in the Briqualand."—Transactions of the Missionary Society, vol. iii. p. 54.

races themselves. The number of inhabitants is small, compared with the great extent of country over which they are scattered, and which consists of the whole of that extensive plain lying between the northern boundary of the colony—the Kamiesberg range of mountains, and the confines of the Orange River. The distribution of the population varies according to the season of the year, the supply of game, and the relation of the tribes to the surrounding inhabitants. In situations where nature is liberal of productions convertible to the support of man, something like small communities are occasionally met with; but in places again, where food is scanty, or water defective, it is rare to find more than one or at least two families together; and those having little or no intercourse with their neighbours, unless when self-defence, or the spoils of some marauding expedition bring them for a time into contact. The fact of their being usually dispersed in such small parties when friendly and well disposed, and of their associating in hordes or troops when projecting and executing mischief, or enjoying the spoils often consequent upon that, frequently furnishes the farmer with a fair guide for judging of their views, and often enables him to discover the retreat of thieves, where those themselves had in the first instance escaped detection.

The little intercourse which they thus have with each other, and the absence of almost every kind of property, render them quite strangers to the great objects of laws, and consequently unconscious of the benefits of a regular Government. They have, therefore, really either hereditary or permanently elected rulers; and few, if any, of them are disposed to acknowledge any superiority, except that which physical strength may secure. In situations where a temporary leader is advantageous, and which they consider as only so in war or the chace, they unconsciously give place in the former to the bravest and most dexterous, and in the latter to the most experienced and cunning. They have no established laws by which offences are tried, nor determined punishments by which aggressions are avenged; every individual is his own lawgiver, and every crime is punished according to the caprice of the sufferer, or the relative positions and relations of the implicated parties. The absence of everything like system renders punishments amongst them very unequal, and often extremely disproportionate to the crimes they are employed to retribute. It permits injuries of the highest order often to be inflicted with impunity, and others of the most insignificant character to be visited with the most hideous vengeance; yet,

yet, nevertheless, such is the satisfaction of all with their present circumstances, in relation to such points, that they cannot be persuaded that it is better to be governed and protected by acknowledged and constituted regulations, than be subject to the varying whims of every mind.

The Hottentot Bushman presents most of the physical characters of the race as exemplified in other situations, and the mixed description, according to circumstances, exhibits more or less of the appearances of the Negro or Caffer. In size and strength, the former is at the very least equal to the Hottentot elsewhere, and is certainly not, as has been generally affirmed, of inferior stature to the members of the savage tribes by whom he is partially surrounded. All have an expression of acuteness and energy beyond that of their coloured neighbours, and a gait and activity peculiarly striking. Their eyes bespeak a habit of watchfulness and scrutiny particularly characteristic, and their demeanour indicates a constant habit of apprehension and fear. They appear to survey every stranger as if an actual enemy, and only waiting a favourable opportunity to injure them; and they do not, until after very considerable intercourse, appear easy in such company. This evidently arises from a consciousness of their offences, and a conviction that their habits and general conduct towards all other nations or tribes are of such a character as warrant anything but the kindness or friendship of strangers. On several occasions I endeavoured to convince them that the Cape Government and the farmers were, in spite of all the depredations and murders they had committed on the colonists, yet inclined to deal liberally with them; but in none of these attempts did I perceive the slightest disposition to give a credence to these assurances, but a distinct persuasion that such was not the case, or rather, *could not be so*, considering their own aggressions; and therefore must be only a pretence employed with a view to deceive them. The dictates of their own hearts, perhaps, never lead them to forgive an injury, so that it is only a conviction or belief of inability that induces them occasionally to forego a punishment; and as they are in the habit of feeling and acting in relation to others, they naturally fancy others must be in regard to them. Hence arises the necessity of being acquainted with the characters and views of savages, in order to be able to judge how far principles fitted for the management of nations stored with both civil and moral knowledge are suitable for such as are, in a great measure, strangers to either; and, consequently, without the very means necessary to enable them to comprehend the more abstruse and complicated rules and regulations

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calculated for the guidance of man in a state of actual civilization.

Most Bushmen pertinaciously avoid every communication with foreigners, and resort to the most unfrequented and inaccessible spots, upon the actual or even supposed approach thereof. They are deeply versed in deceit, and treacherous in the extreme, being always prepared to effect by guile and perfidy what they otherwise are unable to accomplish*. Such treachery, however, though glaringly conspicuous, appears certainly to be resorted to more as a means suggested by reason and observation, to compensate for the inequality that exists between them and their more powerful neighbours, than to proceed from the operation of abstract vicious and dishonourable principles. They are, therefore, not divested of that which under other circumstances such attainments would give reason to suspect,—namely, personal bravery. That, all of them enjoy in a very distinguished degree, and display in no mean proportion in every situation, but more especially when opposed to powers adventitious to those of their own tribes, and upon whom they have been led from infancy to look with impressions of horror, detestation, and dread.

Though well aware of the inferiority of their own weapons, when compared with fire-arms, yet when they discover that it is necessary to oppose the latter, they manifest a remarkable degree of courage, and a perseverance and coolness which only the absence of fear could enable them to support. On such occasions, instances have been known of individuals who have had their left arms completely disabled, employ their toes to fix their bows, so as to be able to continue their defence; and many have been observed to persevere in resistance, after being wounded or maimed in such a way as to occasion almost immediate dissolution. Such violent opposition, and often absurd inflexibility, appear to be excited partly by the influence of their unconquerable passions, and partly by the dread they entertain of falling into the power of enemies, whom they believe as certain either to destroy them at the instant, or convert them into slaves. The coolness and indifference with which almost the whole of the Hottentot race regard the approach of death, has often been commented upon;

* The Rev. Mr. Kicherer, a Missionary, who laboured for some time amongst the Bushmen, at a station on the Zak River, says—"Another singular escape from death deserves to be recorded. In the evening of a day which was uncommonly sultry, I was sitting near an open window, when a concealed party of Boschmen were just about to discharge a volley of poisoned arrows at me; but, by the same girl who saved the life of Brother Kramer from the danger of Vigilant, they were detected, and made off in haste."—Transactions of the Missionary Society, vol. ii. p. 21.

and

and though it must be acknowledged to be strongly marked in all of them, yet from what I have myself seen as well as heard, I feel disposed to consider it as most conspicuous amongst the Bushmen. These, though they show an inclination to escape where danger is imminent, yet if they find that not to be accomplished with facility, they encounter their fate with scarcely the appearance of reluctance or concern; they yield up their lives without the slightest semblance of fear, and even view the approach of death with so little emotion, as almost to incline one to deny them the feelings of reasonable beings. As one example of such hardihood, I may instance the murderer of the late Mr. Trelfall, who, at the time when the executioners were in front of him, and ready with their weapons to inflict the punishment which his barbarous conduct so imperiously demanded, observed, in reference to some part of a person's conduct who was present, and which displeased him, that he only wished he had him—the offensive person—on the other side, (meaning of the Orange River,) and that he would do for him also.

Cruelty is familiar to the Bushmen in its most shocking forms, and is exercised without remorse upon all such as, under untoward circumstances, fall within their reach. The love of revenge is one of the strongest feelings to which they are obnoxious; it urges often to the most barbarous proceedings, and induces to outrages of the most hideous character, merely to satisfy momentary irritation, or the ranklings of a long-fostered malice. Under such ascendancies, pitiable is the individual who falls within their power, as he is certain of being subjected to the most agonizing tortures while life exists, and to mutilations and disfigurations the most intolerable to sympathy, and appalling to observation, at the very latest, the moment that has fled. Their eagerness after retribution is so urgent, as to render it a matter of indifference on whom it is practised, provided the sufferer be believed to be of the same country as the individual or individuals who may have injured or annoyed them, and in this way the innocent are constantly made to suffer for the guilty.

From what I have been able to observe, as to their inclination towards cruelty and revenge, I almost feel disposed to consider such as peculiarly vigorous in the Bushmen, more especially as I have on many occasions seen both of them exercised towards their own relations, with as much rancour as they could be towards strangers; and several instances have come within my own knowledge, where parents were destroyed by their own children, as well as examples of the most decided inhumanity of the former to their offspring, both of which were

were boasted of by themselves and lauded by their companions*. The passion of anger has amazing influence over them, and numerous are the cases in which lives are destroyed while under its ascendancy. Such constant and unlimited submission to momentary feelings, disposes them to act almost constantly upon the impulse first received, and deprives them of the benefit of that consideration and reflection requisite to discover consequences beyond their immediate effects. Such total want of thought induces them to act with the greatest indiscretion, and tutors their minds for only the concerns of the moment: hence the idea of futurity seldom gives them uneasiness; and the prospects of tomorrow, or a time to come, are to them no subjects of importance. If they can only enjoy the passing hour, that is all they look for, and in doing that, they are often so much wrapt up in indifference to everything else, that they not unfrequently neglect the precautions which in their situations are necessary for their existence and preservation, which decided indiscretion necessarily renders them subject to much uncertainty in regard to the means of subsistence; and while it paves the way to abundance at one time, equally ensures want and scarcity at another.

In mixed society, the Bushmen are less talkative and frolicksome than other Hottentots, which appears to arise from their want of confidence in persons of any community, save of their own. Unlike others of their race, who unheedingly enjoy themselves in all societies, and in every situation, they exhibit signs of constant uneasiness and watchfulness; and instead of receiving with pleasure and cordiality the jokes of their associates, they seem to experience annoyance therefrom, and almost an inclination to acts of resentment. They are capricious in the extreme, and uncertain in every situation, and it is not without explanation that many of their proceedings can appear accountable to strangers.

They are notoriously patient of toil, and vigorous in a very

* They take no great care of their children, and never correct them except in a fit of rage, when they almost kill them with severe usage. In a quarrel between father and mother, or the several wives of a husband, the defeated party wreaks his or her revenge on the child of the conqueror, which in general loses its life. Tame Hottentots seldom destroy their offspring, except in a fit of passion; but the Boschemen will kill their children without remorse on various occasions; as when they are ill-shaped; when they are in want of food; when the father of a child has forsaken its mother; or when obliged to flee from the farmers or others, in which case they will strangle them, smother them, cast them away in the desert, or bury them alive. There are instances of parents throwing their tender offspring to the hungry lion, who stands roaring before their cavern, refusing to depart till some peace-offering be made to him.—Kicherer in Transactions of the Missionary Society, vol. ii. p. 8.

high

high degree; and so accustomed are they to exercise of an active description, that their swiftness becomes remarkable, and their power of continuing it truly astonishing, being such as to enable most of them to keep pace with horses even for days in succession, and often to drive off cattle with more celerity than pursuers can follow. The disposition to laziness so decidedly characteristic of the more regular Hottentots, is equally developed in the Bushmen; and were it not the absolute necessity of daily exertion to procure the scanty means of subsistence, they would doubtless pass their time in indolent practices similar to those pursued where resources are more certain and productive.

The continual use to which they apply the eyes and ears, not only as means of discovering their food, but also as useful agents in self-preservation, renders their senses of seeing and hearing amazingly acute, and capable of furnishing a degree of assistance quite unknown to the inhabitants of quiet and civilized countries. In situations where the eye is unavailable, it is wonderful with what certainty and readiness the ear directs to an object; and again where distance renders sound inaudible, the eye often operates with a precision and force which a person who has never witnessed the like would scarcely be disposed to credit. By the latter alone, they will often discern with distinctness what others require a telescope to distinguish, and discover the nature and appearances of particular objects, when persons less versed in observation would scarcely be able to perceive the figures themselves.

[To be continued.]

XXIII. *An Account of an Aurora Borealis observed at Woolwich on the Night of January 7th,* 1831. *By* Mr. William Sturgeon.

A BEAUTIFUL display of the aurora borealis was observed at this place on Friday night, Jan. 7th, 1831. The aurora commenced with the evening, and was very distinctly seen at about half-past five o'clock, exhibiting an arch of faint yellowish light, bordering a dense black area, which was bounded by the arch and the northern horizon. The aurora became more brilliant as the evening advanced and got darker, darting occasional faint flashes of light upwards from the bright and comparatively steady luminous curve. About half-past six a second, and apparently concentric, bright arch made its appearance at a greater altitude than the former, and continued nearly the whole time of the remainder of the display.

These

These two arches of light were frequently, after this time, very badly defined, ever varying in breadth, and softening gradually into shade, particularly at their convex edges, by the lambent streamers which gently played into the partially illuminated expanse above. These soft gliding streams seemed in continual play between the bright arches, flashing from the convex edge of the lower or innermost, and sometimes blending the two curves into one confused light, but never to that extent as to obliterate the distinction of the two luminous arches, which the eye could always trace by the superior refulgence of their light. Between nine and ten o'clock the altitude of the superior arch advanced from 20° to about 24°, but never ascended higher than that point. The inner, or inferior, arch advanced at the same time, and apparently in the same proportion, so that the *same* distance (about 10°) between the two curves of *strongest light*, was *nearly*, perhaps *exactly*, preserved during the whole time. The extremities of these arches never completely reached the horizon, but were gradually lost in a dark gloom, resembling an exceedingly dense fog, although the atmosphere in every other part was perfectly clear. This appearance was particularly remarked on the eastern limbs, which were lost at various altitudes. The western limbs of the bright curves could not be so distinctly traced at the place where these observations were made, on account of their mixing with the reflected light in the atmosphere, of the burning gas in London, which, at Woolwich, is always seen, in the night, as a bright cloud hovering over the metropolis.

About nine o'clock I called on Mr. Barlow, to inform him of the aurora. Mr. B., however, had seen it all the evening. I remarked before I left him, that the centre of the aurora in the horizon was considerably to the west of the north, and near to the magnetic meridian, a circumstance which he had already observed. I immediately returned home, and having a very delicately suspended magnetic needle, I placed it in a suitable situation for observation, and so far neutralized the magnetism of the earth, as to leave no more power acting on the needle than was barely sufficient to arrange it in the magnetic meridian. I observed this needle, at intervals of two or three minutes, during the remainder of the display of the aurora, but never detected the slightest change in its direction, nor was its repose in the least disturbed by any influence which I could ascribe to that phænomenon.*

At half-past nine the aurora increased in splendour, and shot its beautiful broad streamers upwards, as radii, from the

* See our "Intelligence," in the present Number.

external

external luminous bow nearly to the zenith. At a quarter before ten, an immense faint stream of light kindled in the eastern extremity of the external bow, and flashed directly between the two large stars in the tail of Ursa Major, and in one moment described an arch of 100°. This streamer was not undulatory, but advanced gradually and steadily, leaving the whole of its track, for about a minute, in a steady glow of faint light: it then languished in every part, at nearly the same moment, gliding into still fainter light, and soon became entirely lost. About this time faint undulatory streams of light sprang from various parts of the central aurora, and sometimes broad streaks of wavering light were seen glowing in the black area near the horizon. These latter displays, however, were not frequent, but on account of the contrasting blackness with which they were surrounded, appeared more brilliant than those flashes which occurred on the upper skirts of the aurora.

At a quarter past ten, beautiful streamers were seen kindling upon the western limb of the superior arch of the aurora, some of which instantly expanded into an attenuated light, which became extinct at a short distance from the point of their origin; whilst others, more permanent and brilliant in their display, stretched forth to an amazing distance in the heavens, and extended their lambent glow to beyond the planet Mars; but, like those which had before measured a vast arch of the heavens from the eastern limb, they in a few moments vanished for ever.

Soon after these displays of extensive streamers, there seemed a steady pause, as if the electrical powers which gave them birth had become partially exhausted. The steady light of the two concentric arches, with a few faint flashes about their edges, were the only traces of the aurora. The cessation however was not of long duration, but the interval gave time for reflection. The night was calm and serene, not a breeze ruffled its repose, nor a cloud curtained any part of the heavens, save that dense black speck which seemed as a nucleus to the whole display of the aurora borealis. The atmosphere was cold and frosty, and the stars shone in all their splendour and glory. On turning towards the south, the spectacle presented to the eye was truly grand and imposing, and formed a most beautiful and striking contrast with the phænomena displaying in the north. Taurus had passed the meridian, preceded by the planet Mars, and Orion was now mounting the throne of night; refulgent Sirius blazed in the south-east of the stellar train, and enhanced the splendour and solemnity of the scene. In one part of the heavens was displaying the

quivering blaze of a transient aurora; in another, the sparkling light and steady march of a transcendent starry host: in the north, a splendid exhibition for the contemplation of the Electrician; in the south, those glorious orbs which are the objects of the Astronomer's research.

About half-past ten the eastern limb of the aurora again shot forth immensely broad streaks of light, with intervening dense shades. These streamers soon expanded, and mixing with each other presented a steady uniform field of light. Other similar streamers darted upwards from the western limb, and expanding like the former heightened the illumination, which now extended to nearly half the concave of the heavens. The light vanished gradually, and was succeeded by faint streamers of much less magnitude. The dark space below the inner arch was now, for a short time, well defined by the bright glow round its upper edge; but it soon became confused and irregular. At eleven a streak of bright light, like a yellowish cloud, stretched horizontally towards the east. In one moment after a streamer kindled at its eastern extremity, and shot gradually upwards; passed the meridian, and terminated in a very faint light between Aldebaran and the Pleiades. About this time the undulatory streamers became beautiful and grand, playing in every part of the northern heavens to nearly the zenith, and on each side of the meridian to about the north-east and north-west points. Some bright coruscations occasionally flashed in this part of the display, and gave to it an exceedingly interesting appearance. A few moments dispersed these coruscations, which were succeeded by a diffused faint light. The dense central darkness now suddenly disappeared, and a bright light illuminated the northern horizon, for the first time since the setting of the sun. A dark broad streak soon stretched obliquely downwards, from east to west, nearly through the centre of the aurora, and bright coruscations flashed in rapid succession from its upper edge.

About a quarter-past eleven the dark central speck again appeared, and some very bright streamers ascended from various parts of its upper or convex edge, which, as before, was now bordered by a bright steady light. Coruscations frequently about this time reached to between the pointers in Ursa Major; they soon became very faint, and were succeeded by a dull steady light.

At half-past eleven the streamers became less frequent, the dense nucleus was ill defined, and the whole display began to languish. A bright curved light however, with occasional ascending lambent streams, continued to direct to the general centre of the aurora, which now appeared to approximate closer

closer to the north point than in an earlier part of the display. The centre of the dark nucleus, however, was, from first to last, *west* of the north, and very near to the magnetic meridian.

From twelve o'clock nothing occurred worthy of remark: the splendour of the aurora gradually declined, and at two on Saturday morning it had totally vanished.

I observed, during the whole of the night, that the streamers, besides the vertical direction in which they generally shot, had also a horizontal motion from east to west; so that in whatever part of the aurora a streamer was kindled, it travelled slowly towards the west, or towards the left hand of a spectator facing the north. It frequently happened that several were lighted up in rapid succession, each of which was always *west* of the preceding one. A meteoric star, which traversed the aurora about ten o'clock, also fell sloping in the same direction.

Artillery Place, Woolwich, Jan. 10, 1831. W. STURGEON.

N.B. On Saturday night (Jan. 8th) the aurora was again visible. I saw it about ten o'clock. It exhibited no coruscations, nor any flashes whatever. The only display was a broad arch of light, bordering the upper edge of a black area of the heavens in the north, and similarly situated to that which appeared the preceding night. At eleven o'clock no trace of the aurora was to be seen.

XXIV. *Notices respecting New Books.*

Sections and Views illustrative of Geological Phænomena. By H. T. DE LA BECHE, Esq.. F.R.S. F.G.S. Treuttel and Wurtz: London, 1830.

NOTHING is so much calculated to facilitate the study of geology as the representation of its phænomena through the medium of coloured views, sections and maps.

Mr. De la Beche is known to our readers as the author of many valuable contributions to the Geological department of our Journal; and the taste and skill with which he has applied his talent of drawing to illustrate the phænomena of geology have, for some time past, contributed to enrich the Transactions of the Geological Society of London. His large tabular and proportional view of the superior, supermedial, and medial rocks, published a few years since, has entitled him to the gratitude of every student in geology; and we hail the appearance of the work before us as a more extensive contribution of a similar kind, tending, more than any other publication that has yet appeared, to render easy and familiar many of the most difficult and complicated phænomena of the original

 structure

structure of the earth's surface; and also of the violent changes and physical revolutions by which it has been disturbed. It has been the object of the author to convey his information through the medium of 40 plates, accompanied by brief descriptions. The number and size of these plates are such as it would have been impossible to publish at the price affixed to the volume, had they not been almost all lithographed by the author himself.

Mr. De la Beche appears to have had a twofold object in this work: 1st, to present correct sections and views of the most remarkable geological facts that have been observed in various parts of the world; 2ndly, to point out the importance of observing accurate proportions in these miniature representations of natural phænomena. He disavows all intention of supporting any theory that has been yet advanced, conceiving that none has yet been published which is competent to solve the many difficult and complicated problems presented by geology. But whilst he is the advocate of no theory, he points out the errors and unsoundness of many, especially of that fundamental article of the Huttonian theory, which attributes the excavation of valleys to the action of rain-water and of rivers that now flow through them;—many of his sections represent facts which it is impossible to reconcile with such a theory. In his preface, he quotes from M. Boblaye the case of the valley of the Meuse, showing that if it had cut its own bed, it must have run up hill at least 300 yards to form its present channel through the Ardennes, instead of passing into the basin of the Seine over barriers not exceeding 30 or 40 yards in height.

The Sections and Views are selected from numerous works through which they are scattered; and in collecting his facts together from these various sources, the author has endeavoured to exhibit their relations to one another, and to the whole earth, and to concentrate their force in pointing towards conclusions which may hereafter be fully established by induction from more numerous particulars.

Besides the sections derived from other authorities in published works (chiefly the Geological Transactions), the author gives some new and unpublished sections made by himself in different countries.

We subjoin one or two examples of his method of showing the value of proportional sections.—In Plate 1. are represented two parallel columns, or vertical sections, one showing the thickness of all the strata that occur in Yorkshire, from the chalk descending to the carboniferous limestone (inclusive); the other showing the thickness of the same strata in Wilts and Somerset: thus, at once presenting to the eye the relative proportions of the same deposits in the Northern and Southern extremities of England. In Pl. 2. he represents on a true scale the exact outline of the Alps from the Jura Mountains across the Lake of Geneva, and Mont Blanc to Italy, and contrasts these real representations with the false and caricatured figures which are usually given in geological sections. A further example of the value of accurate measurement is pointed out in Pl. 40; where he exhibits the relative proportion which the highest

highest mountains bear to the radius of the earth, and also the relation which the body of the earth itself bears to the sun. Measured by such a scale, the highest peaks of the Himalah appear utterly insignificant, and the greatest disturbances which have affected the surface of our planet seem too small and trifling to produce any appreciable effect upon the great mass of the interior of the earth.

Figures of this nature, as the author observes, give more correct and definite ideas of the relative value of things than can be conveyed by voluminous pages of description, unaccompanied by drawings that represent their true proportions.

XXV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

1830. Dec. 16.—A PAPER was read, entitled, Researches in Physical Astronomy; by John William Lubbock, Esq. V.P. and Treasurer of the Royal Society.

The author has shown in a former paper, published in the last part of the Philosophical Transactions for 1830, that the stability of a system of bodies subject to the law of gravitation, is always preserved, provided they move in a space absolutely devoid of resistance. This conclusion results from the analytical expressions for the variations of the elliptic constants in the theory of the Planetary Motions.

In the present paper he extends his researches to the problem of the precession of the Equinoxes, which admits of a similar solution to the former. Of the six constants which determine the position of the revolving body, and the axis of instantaneous rotation, at any instant, three have only periodic inequalities; while the other three have each a term which varies as the time; but from the manner in which these constants enter into the resulting expressions, the equilibrium of the system may be inferred to be stable, as in the former case. By the stability of the system, the author wishes to be understood to mean that the pole of the axis of rotation has always nearly the same geographical latitude, and that the angular velocity of rotation, and the obliquity of the ecliptic vary within small limits; and that its variation is periodical.

The author also gives new methods of obtaining the inequalities of longitude, and the radius vector, in the planetary theory, retaining the square of the eccentricities. When only the first powers of the eccentricities are retained, these expressions admit of simplification. He subjoins, as a numerical example, the calculation of the coefficients of two of the inequalities of longitude in the theory of Jupiter disturbed by Saturn; and points out the requisite substitutions for rendering the formulæ applicable to the case of a superior planet disturbed by an inferior planet.

Dec. 23.—A paper was read, On the Hour Lines of the Ancients; by W. A. Cadell, Esq. F.R.S.

The hour lines on the sundials of the ancient Greeks and Romans correspond

correspond to the division of the time between sun-rise nd sun-set into twelve equal parts, which was their mode of computing time. An example of these hour lines occurs in an ancient Greek sundial, forming part of the Elgin collection of marbles at the British Museum, and which there is reason to believe had been constructed during the reign of the Antonines. This dial contains the twelve hour lines drawn on two vertical planes, which are inclined to each other at an angle of 106°; the line bisecting that angle having been in the meridian. The hour lines actually traced on the dial consist of such portions only as were requisite for the purpose the dial was intended to serve: and these portions are sensibly straight lines. But the author has shown, in a paper published in the Transactions of the Royal Society of Edinburgh, that if these lines are continued through the whole zone of the rising and setting semidiurnal arcs, they will be found to be curves of double curvature on the sphere. In the present paper the author enters into an investigation of the course of these curves; first selecting as an example the lines indicating the 3rd and the 9th hours of the ancients. These lines are formed by the points of bisection of all the rising and setting semidiurnal arcs; commencing from the southern point where the meridian cuts the horizon, and proceeding till the line reaches to the first of the always apparent parallels, which being a complete circle, it meets at the end of its first quadrant. At this point the branch of another and similar curve is continuous with it: namely, a curve which in its course bisects another set of semidiurnal arcs, belonging to a place situated on the same parallel of latitude as the first, but distant from it 180° in longitude. Continuing to trace the course of this curve, along its different branches, we find it at last returning into itself, the whole curve being characterised by four points of flexure. If the describing point be considered as the extremity of a radius, it will be found that this radius has described, in its revolution, a conical surface with two opposite undulations above, and two below the equator. The right section of this cone presents two opposite hyperbolas between asymptotes which cross one another at right angles. This cone varies in its breadth in different positions of the sphere: diminishing as the latitude of the place increases.

The cones to which the other ancient hour lines belong, are of the same description, having undulations alternately above and below the equator; but they differ from one another in the number of the undulations: and some of these require more than one revolution to complete their surface. The properties of the cones and lines thus generated, may be rendered evident by drawing the sections of the cones on the sphere, in perspective, either on a cylindrical or on a plane surface: several examples of which are given in the paper.

GEOLOGICAL SOCIETY.

Dec. 15.—A paper was first read, entitled, An Explanatory Sketch of a Geological Map of Transylvania, by Dr. Ami Boué, For. Mem. G.S.

The author premises that this sketch, having been written before his specimens

specimens were unpacked, is necessarily incomplete, both from that cause and from various impediments which obstructed his observations.

Transylvania is described as being chiefly occupied by a high tertiary basin, surrounded by four chains of mountains, viz.: 1. On the south by the primary range of Wallachia or Taganrasch. 2. On the west by another primary range, usually omitted by geographers; and connected with a high calcareous chain near Kronstedt, and a ridge of Carpathian sandstone near the pass Oytosch. 3. By the trachytic hills separating the low tertiary and saliferous districts from the great valley of the Secklerland. 4. By a large group of conical porphyritic hills, with metalliferous summits, ranging by Korosch Banya, Zalathria, Vorospatak, &c. Many of these hills are stated to average from 3000 to 4000 feet in height, and the highest peaks to exceed 6000 feet. The author, describing the course of the rivers, remarks that the hydrographical features are inaccurately given in all maps, and that most of the streams cut through the above chains by gorges of very recent fracture. The primary rocks, he says, consist of gneiss and slate; and that in the latter, serpentine, granular limestone; and metalliferous veins are found wherever sienite comes into contact with the slate. The Carpathian sandstone with Fucoids (Vienna sandstone) is mentioned as occurring in the N.E. and S.E. of Transylvania;—that it surrounds the auriferous porphyries of Nagy and Banya, and that at Laposbanya the marls and slaty sandstones of this formation are much altered by dykes of sienitic porphyry, presenting examples of jaspideous rocks like those of Portrush, Skye, &c.

The author is disposed to think that there are evidences of two or even more periods of igneous eruption, and that the scoriaceous trachytic porphyries cut through and frequently overflowed the metalliferous porphyries. These porphyry districts are cited as offering repeated and decisive proofs of the igneous origin of metalliferous veins; all the walls of which are altered and discoloured:—large masses of the rock are traversed by millions of auriferous rents,—and gold is found in the sandstone as well as in the porphyry.

The remaining secondary formations are stated to consist of a kind of recent Jurassic, compact limestone, associated with conglomerate, covered, here and there, by patches of sandstone and marl containing some of the fossils of Gosau. Near Sass Vorosch, Kis Numtschel, Kis Aranyos, &c., deposits of about the same age are said to have been observed by M. Partsch, and that they have been further described in the Buskowine by that gentleman, and by Messrs. Von Lill and Rudolph. The tertiary deposits, like those of Hungary, are considered to be entirely of the upper class, and they are shown to consist of clay, marl, and molasse, with salt, gypsum, lignite, &c. The molasse, the author says, is generally covered by shelly sands and gravel, but occasionally by a sandy, coarse limestone; and that near Illyefalva à Arapatak, these sands contain many freshwater mixed with some marine shells. Near the Rothethurm pass, and west and north of Klaurenburg, he shows there are thick deposits of nummulitic and coral limestone,

limestone, equivalent to the highest tertiary limestone of Austria and Hungary. Fichtel is quoted as the earliest and best geological writer upon Transylvania, particularly as to the localities of shelly deposits and salt springs; and it is stated that from his work alone M. Beudant was enabled to compile a map of this country.

For an account of the eastern chain of trachytes the author refers to what he has already written in Dr. Daubeny's work on Volcanos:—he inclines to the supposition that the scoriaceous trachytic porphyries were erupted during the cretaceous or perhaps even during the old tertiary period; and he dissents from M. Beudant as to the possibility of drawing any distinct line of demarcation between the trachyte and porphyry in those places where these rocks are contiguous, although when at great distances from each other he allows the dissimilarity of their respective characters. A stratified, pumiceous and trachytic conglomerate, it is stated, frequently overlies the salt in Transylvania, and contains impressions of dicotyledonous plants, leaves, and fishes. The extinct craters of St. Annalake and the solfatarra still burning in the trachyte of Budoskegy, and the many acidulated and mineral springs, are considered by the author clearly to indicate the recent age of some of the volcanic phænomena in this country, to the principal entrance of which, the Romans assigned the name of "Vulcan's Pass."

A paper was then read, On the Astronomical Causes which may influence Geological Phænomena; by J. F.W. Herschel, Esq. F.R.S. F.G.S., &c., &c.

The author states his object in this paper to be, an inquiry into the possible geological influence of slow periodical changes in the orbits of the earth and moon, such as have been demonstrated by geometers to take place in consequence of planetary and solar perturbation. Such influence he regards as extending only to the production of changes in the amount of the tides and their consequent erosive action on our continents, and of periodical fluctuations in the quantity of solar heat received by the earth, every such fluctuation being of course accompanied with a corresponding alteration of climates; and therefore, if sufficiently extensive and continued, giving room for a variation in the animal and vegetable productions of the same region at different and widely remote epochs.

The subject of the tides is first considered. Since any approach of the moon to the earth produces an increase of the lunar tide in the triplicate ratio of such approach, it follows that any diminution of the moon's mean distance must produce an increase in the average tide during the whole period that such approach subsists. The mean distance of the moon is actually on the decrease, and has been so for ages past, producing the astronomical phænomenon of her *secular acceleration*. The mean amount of the tides, therefore, has long been, and will long continue to be, on the increase from this cause, but the effect of it is shown to be confined to such moderate limits as to be of no geological importance.

The author next considers the possible effect of an increase in the excentricity of the lunar orbit, which would affect not the *ave-*

rage

rage but the extreme rise and fall of the tides. Such an increase, however, he regards as necessarily limited, so as to be incapable of producing such an enormous increase of tides as would account for any of the greater diluvial phænomena, though possibly cases of great local devastation in estuaries and confined channels would arise, and the outlines of the continents, in particular parts of their coasts, might be materially modified by such increased occasional action. No change in the earth's orbit within the limits of possibility would produce any material change in the solar tides.

He next considers the effect of planetary perturbation on the earth's orbit, and, dismissing the variation of the obliquity of the ecliptic, which is known to be confined within very narrow limits, he regards the excentricity as the only element whose variation can possibly have any effect of the kind in view; and that by affecting, first, the mean, and secondly, the extreme quantities of solar heat received by the earth in its annual revolution, and at the different seasons of the year. First, with respect to the mean quantity, he announces as a consequence of geometrical reasoning, the following theorem:—*That the mean annual amount of heat and light received from the sun by the earth, is inversely proportional to the minor axis of the ellipse it describes at different epochs.* And since the orbit of the earth is actually, and has been for ages, beyond the records of history, becoming less elliptic, and the minor axis consequently increasing, it follows that the mean temperature of its surface *is* on the decrease. The orbit being now very nearly a circle, this decrease cannot go much further; but should it ever have been very elliptic, the mean temperature must have been sensibly greater than at present. The author regards the limits within which the earth's excentricity is confined, as (although calculable) not actually known; and he denies in particular that the theorem demonstrated by Laplace, in the 57th article of the Second Book of the *Mécanique Céleste*, equation (u), which is usually cited as proving the narrowness of such limits, affords any ground for that conclusion in the case of the earth's orbit, however it may do so for those of the great preponderant planets.

Under this uncertainty he considers himself authorized to assume, that excentricities *actually existing* in the orbits, both of superior and inferior planets, may not be *impossible* in that of the earth; and admitting this, he calculates the mean and extreme amounts of solar radiation in an orbit so circumstanced. The mean amount he finds to exceed the present by about three per cent, a quantity apparently small; but he adduces considerations tending to show, that on certain suppositions not impossible or improbable in themselves, this per-centage on the whole quantity of solar heat may have influenced our climates to as great an extent as geological indications appear to require.

Considering next the extreme effects of such a state of things, and adopting a view taken by Mr. Lyell in his Geology, he shows that by reason of the precession of the equinoxes combined with the mo-

tion of the apogee of the earth's orbit, the two hemispheres would alternately be placed in climates of a very opposite nature, the one approaching to a perpetual spring, the other to the extreme vicissitudes of a burning summer and a rigorous winter; and that, during periods sufficiently long to impress a corresponding character on the vegetable and perhaps the animal productions of each.

LINNÆAN SOCIETY.

Jan. 18, 1831.—Edward Forster, Esq. in the Chair.

The paper read was entitled, A Notice of several recent Discoveries in the Structure and Œconomy of Spiders; by John Blackwall, Esq., F.L.S.—The object of the author's particular investigation is the *Clubiona atrox*, of whose habits, and mode of fabricating its residence and its snare, he gives a detailed and curious account.

ASTRONOMICAL SOCIETY.

Nov. 12, 1830.—The following communications were read:

I. Ephemeris of the occultations of α Tauri in 1831, for ten European Observatories, by Mr. Maclear.

II. Practical rules for the approximate prediction of occultations, by Mr. Henderson.

III. A note by Mr. Gompertz, to a paper by M. Kreil on the rectification of the equatorial.

IV. Occultations observed at Boston, Massachusetts, by Mr. Robert Treat Paine.

Mr. Paine gives the mean solar time of six complete observations of Aldebaran (immersion and emersion), five at Boston and one at Nantucky, with a $3\frac{1}{2}$ feet achromatic telescope, and a magnifying power of 60: the telescope was adjusted on a star. "In four of the observations nothing remarkable was noticed, except that when the immersion or emersion took place on the enlightened limb, the star became so tremulous as to cause an uncertainty of 1^s or 2^s; but in two other instances (one at emersion and the other at immersion) the star did actually appear projected upon the face of the moon for about 2^s; and the light of the star was in both instances very much more brilliant than usual, although the emersion took place about sunset, and the immersion while the sun was above the horizon."

"On September 17, 1829, about 10^s before immersion, the star spread out, and appeared like a star viewed through a telescope not adjusted to distinct vision, and then faded away so gradually that its final disappearance could not be noted with greater precision than 3^s or 4^s. The same appearance was seen by another gentleman observing at a place $2\frac{1}{2}$ miles distant from me."

V. Observations upon the period of the variable star β Lyræ, by Mr. W. R. Birt.

In the year 1784, Mr. Goodricke remarked that β Lyræ varied from the third to the fifth magnitude, and fixed the period of this variation at $6^d\ 9^h$. On the 22d May, 1830, Mr. Birt commenced a series

series of observations upon this star, and at 11 hours found it of the fifth magnitude, and equal to ε and ζ Lyræ. Supposing the period to be that assigned by Mr. Goodricke, eight revolutions would have been performed in fifty-one days exactly; but when viewed by Mr. Birt on the 12th of July, at 10 o'clock, it was about 3·4 magnitude, and less than γ Lyræ; while on the 13th it was decidedly of the fourth magnitude, and on the 14th of the third, or as bright as γ. Mr. Birt therefore concluded that it came to its minimum brightness between the 12th and 13th, and that the period was therefore longer than that assigned to it by Mr. Goodricke. This conclusion was confirmed by an observation on the 2nd of September, when, at 11 o'clock, the star was exactly equal to ε and ζ, as on the 22nd of May, thus giving 103 days for sixteen revolutions, or a period of $6^{d}\ 10^{h}\ 40^{m}$, instead of 102 days, which would have been required if the period were $6^{d}\ 9^{h}$. It would seem that the duration of its maximum, as well as of its minimum brightness, is somewhat irregular. Mr. B. gives several comparisons of the star with γ, ε, and ζ Lyræ, from May 22 to September 15.

VI. A paper on terrestrial refraction, by the late Mr. Henry Atkinson.

On the fluctuations of the atmosphere near the earth's surface; and

On the effect of such fluctuation upon the refraction at the horizon, and at very low altitudes, especially on the dip of the horizon at sea.

(*Unfortunately, these papers are unfinished: the ingenious author did not live to complete them.*)

In these investigations Mr. A. proposed to himself to demonstrate,

1st, The the fluctuations in the state of the atmosphere near the surface of the earth are not only fully adequate to account for the very great variations which have been observed in the horizontal refraction, but even for still greater variations.

2ndly, That the variations of the dip of the horizon at sea are caused by the fluctuations of the atmosphere, and can be calculated when the latter are known.

The extreme uncertainty of the law of the variation of temperature near the earth's surface has been remarked by every observer who has directed his inquiries to this subject, by a proper adaptation of course and distance to the circumstances of the problem.

We find well-recorded cases where small alterations of elevation have produced very sensible effects upon the air, sometimes increasing and sometimes diminishing its temperature; and, again, at other times, we find the temperature of the air nearly the same through very considerable altitudes. (See Wells, Humboldt, &c.)

In order to subject to calculation the different hypotheses which may be imagined, Mr. A. supposes that the variations of temperature may be actually observed within certain limits of altitude (he has here assumed fifty feet); and that the state of the atmosphere at great elevations, for example at 1125 feet above the surface of the earth, may be considered to be in a *mean state*. Considering the state of these upper and lower portions of the atmosphere to

 remain

remain unchanged, he calculates the change in the whole horizontal refraction which would be produced by two arbitrary and very dissimilar suppositions as to the distribution of temperature in the intermediate portion of 1075 feet, and draws the conclusion, that the variation of refraction arising from any conceivable derangement in this middle portion will be inconsiderable, compared with that which may be produced by changes in the lowest portion.

In considering the problem of the dip of the horizon, Mr. A. first obtains an expression for it where there is no terrestrial refraction, and deduces this simple approximate formula, that the dip in seconds $= 63''{\cdot}82 \times \sqrt{h}$, where h is the altitude in *feet* above the level of the sea.

But when account is to be taken of the terrestrial refraction, Mr. A. finds, that if the included arc of the earth's surface be to the terrestrial refraction as $n:1$ (and this is to be determined from a table of terrestrial refraction according to the then existing state of the atmosphere), the preceding expression is thus modified. The

$$\text{dip in seconds} = 63''{\cdot}82 \times \sqrt{\frac{n-2}{n}} \times \sqrt{h}.$$

ZOOLOGICAL SOCIETY.

Dec. 28, 1830.—W. Yarrell, Esq. in the Chair.

The form of a circular letter, to be addressed to the heads of Menageries and Museums in foreign countries, was submitted to the Committee, and approved of.

A letter was read, addressed to the Secretary of the Society by J. V. Thompson, Esq., dated "Cork, Dec. 16, 1830." In it Mr. Thompson urges, in support of the universality of a metamorphosis among the *Crustacea*, that he has ascertained the newly hatched animal to be a *Zoea* in eight genera of the *Brachyura*, viz. *Cancer, Carcinus, Portunus, Eriphia, Gecarcinus, Thelphusa?, Pinnotheres,* and *Inachus*; and in seven Macrourous genera, viz. *Pagurus, Porcellana, Galathea, Crangon, Palæmon, Homarus,* and *Astacus.* "These embrace all our most familiar native genera of the *Decapoda.*" The *Lobster,* or *Astacus marinus,* Mr. Thompson states, "does actually undergo a metamorphosis, but less in degree than in any other of the above-enumerated genera, and consisting in a change from a cheliferous *Schizopode* to a *Decapode*; in its first stage being what I would call a modified *Zoea* with a frontal spine, spatulate tail, and wanting the subabdominal fins; in short, such an animal as would never be considered what it really is, was it not obtained by hatching the spawn of the *Lobster.*" In the other indigenous species of *Astacus, Ast. fluviatilis,* the *River Crawfish,* it would appear from the excellent treatise of M. Rathke on the developement of its eggs, that the young are hatched in a form according with that of the fully grown animal. Mr. Thompson, however, suspects that some source of error may exist in these observations. "If it should be found otherwise, it can only be regarded

regarded as one solitary exception to the generality of metamorphoses, and will render it necessary to consider these two animals for the future as the types of two distinct genera." In illustration of the change of form observed by him in the limbs of the *Lobster*, Mr. Thompson inclosed a sketch of the "cheliferous member of its *larva*," which is represented as divided to its base, and consisting of, 1. a cheliferous portion; 2. a portion of equal length with the preceding and terminated by natatory ciliæ (described as the outer division of the limb, or future *flagrum*); and 3. a short rudiment of one of the future *branchiæ*.

A specimen of the *Labrus maculatus*, Bloch, presented to the Society by Sir A. Carlisle, was exhibited. When quite recent, its rich deep blue colouring was stated to have been extremely beautiful; but this had already disappeared considerably, although the specimen had been but twelve days in spirit. Still enough remained to show how defective in this particular is the figure in Bloch's Ichthyology [No. 294.], which appears to have been taken from a dried specimen, and exhibits scarcely a trace of the rich colouring of the recent fish.

The Chairman brought to the recollection of the Committee the recent addition to the British Fauna of a species of *Warbler* (the *Sylvia Tithys*, Scop.) nearly allied to the *Redstart*, *Sylvia phœnicurus*, L., but distinguished from that bird by its dark slate-coloured breast, and by the dusky-black colour of its two middle tail-feathers. The first occurrence of this bird in England was recorded in the 5th volume of the "Zoological Journal," page 102, by Mr. John Gould, who has since ascertained that two other individuals have been met with; one in the neighbourhood of Bristol, the other at Brighton. Both these specimens were obtained during the last summer. The Chairman added, as a peculiarity of this bird, that its egg, as described and figured by continental writers, is white; while the eggs of all the nearly allied species are pale blue.

A communication by J. C. Cox, Esq., F.L.S., &c., was read, on the subject of preserving a proper temperature for exotic animals. Mr. Cox commences by remarking on the capability of animals for enduring great extremes of temperature, and instances the experiments of Sir Joseph Banks and Sir C. Blagdon, in which a heat of at least 230° was borne without great inconvenience; while, on the other hand, Captain Parry and his men were exposed to a temperature of −40° and even lower: thus showing that the human frame is susceptible of a range of temperature of probably 300°, without injury to life. Such extremes can, however, be submitted to but for a short period. To keep animals, natives of tropical climates, in good health, they should be preserved from too great extremes; and as it is important to imitate as much as possible the character of the climate from which they are brought, the hygrometric state of the atmosphere should be attended to almost equally with the temperature. The hot winds of the Desert (Mr. Cox remarks), together with the absorbent nature of the sandy soil, render the general state of the atmosphere in the central parts of Africa that

that of extreme dryness; but this is an exception to intertropical regions in general. In Guiana and La Plata, for instance, and in Ceylon, the thick woods exhale a considerable degree of moisture, far exceeding that of our own country; the mean dew point of the atmosphere of London being 44°.5, while that of intertropical regions is from 70° to 75°. Animals from such climates, it is suggested, require a moist atmosphere, and this may readily be produced by watering the flues used for heating the houses in which they are kept. Analogous to this is the advantage obtained in the cultivation of stove plants by keeping the houses well watered. The neglect of supplying to the air a sufficient quantity of simple and innoxious moisture is attended with two evils. Not only are the animals kept in an atmosphere too dry for their healthy preservation; but the dry air, greedily absorbing moisture, becomes impregnated with the excreted fluids of the animals in confinement; and thus the secreting surfaces of the lungs are at once exposed to a constant stimulus from increased and rapid exhalation, and to the additional stimulus inflicted by the continual breathing of air loaded with saline and irritating particles. In well constructed houses it is of the first importance that the fluids of the animals should be conducted from the buildings. Ventilation should also be perfect not only through the body of the building, but through each individual cage or den. This is doubly necessary where the air is vitiated, not only by the animals themselves, but by numerous visitors. For the general regulation of the admission of cold air a convenient plan is to have a leaden or iron weight balanced in a vessel of mercury, attached to a sliding sash, which will thus rise or fall in proportion to the height of the mercury. Mr. Cox regards it as of no importance, as to the effect produced on the atmosphere, by what means an increased temperature is preserved, whether by flues or steam or hot water, if the degree obtained be the same: the only reason for preferring one to another is the greater facility it may afford of keeping up an equable temperature.

Mr. Owen read a portion of his notes made at the dissection of the *Beaver* which died lately at the Society's Gardens. He limited himself on this occasion to the description of the organs connected with digestion. The salivary organs and those of deglutition were treated of in detail: the former parts, which are remarkably developed in all the *Glires*, were especially examined on account of the peculiar nature of the animal's food; while the latter claimed particular attention from the recent interesting discovery by Mr. Morgan of a peculiar construction of the *fauces* in the *Capybara* and some others of the Rodent order.

Of the salivary glands the *parotid* are the largest. They are united, like the lateral lobes of the thyroid gland in man, by an anterior transverse portion; and form together a conglomerate mass which extends across the front of the neck to within a short distance of the upper part of the *sternum*, covering the *larynx* and its muscles, and passing backwards on each side as far as the mastoid process. There are, however, two ducts, one on each side, which

which terminate in front of the molar teeth. The *submaxillary* glands are quite distinct from the parotid, and are each about the size of a walnut: their ducts pass under the jaw and terminate at the side of the *frænum linguæ*. The *sublingual* glands are very small.

Between the membrane of the palate and the bone, in the narrow space between the rows of molar teeth, a layer of mucous glands is situated: and a thick stratum of the same kind of glands exists also immediately exterior to the membrane of the *fauces*.

The soft palate extends backwards from the posterior edge of the bony palate as far as the circular aperture of the posterior *nares*. The sides of the soft palate are continuous with the tongue, and, becoming gradually contracted, form *fauces* of a funnel shape, the posterior aperture of which just admits a black-lead pencil of the usual size for drawing. The membrane covering the posterior part of the *dorsum* of the tongue is continued smoothly and uninterruptedly to the *epiglottis*, without the production of any fold of membrane in front of this part, nor was there any corresponding duplicature above, or at the sides of, the *fauces*: so that here no structure existed that would allow any part of the *fauces* to be protruded in a conical form into the *pharynx*, beyond the opening of the *glottis*, as in the *Capybara* and *Guinea-pig*.

The *fauces* of the *Rat* are formed after the same type as those of the *Beaver*: a type which is peculiar, inasmuch as there is properly speaking no *velum pendulum palati*, the membrane forming the roof of the *fauces* being continued straight, without duplicature or reflection, to the posterior aperture of the *nares*: this aperture is of a circular form, on a horizontal plane, and situated immediately above the *glottis*.

The muscular apparatus of the *fauces* consists of a pair of muscles which arise, one from each side of the tongue, and ascend, the fibres diverging a little; their action is to contract the commencement of the *fauces*, being analogous to the *palato-glossi*: besides these there are, at the narrower part of the *fauces*, circular fibres, apparently continued from the superior *constrictor* of the *pharynx*, and analogous to the *palato-pharyngei*.

There are no palatal arches, neither were any tonsils detected.

The peculiar cardiac gland much resembles tonsils in structure, being composed of numerous small glands or follicles, forming an aggregate of about 14 lines in length and half an inch in thickness, which pour a viscid secretion, by numerous apertures, into the interior of the stomach.

The *pancreas* is of considerable extent, measuring in length nearly two feet, and following the course of the *duodenum* down to the iliac region and up again as far as the umbilical, being attached to the intestine by a process of mesentery: it is thin and narrow, and has one small branch or process lying parallel with its body where it passes behind the liver, and a few others at the curvature of the *duodenum*. Its duct, somewhat larger than a crow-quill, enters the small intestine at the extremity of the gland, one foot and nine inches

inches from the *pylorus*, and one foot and six inches from the termination of the *ductus choledochus*.

At the commencement of the *colon* there are two pouches of an oval form, from the union of which the rest of the intestine proceeds with very distinct *sacculi*. An analogous structure exists in the *cæcum* of the *Guinea-pig*, where however the two *sacculi* appear rather to belong to the *cæcum*, being partially separated from the *colon* by a circular production of the lining membrane in a valvular form.

Jan. 11, 1831.—Sir Thomas Phillipps, Bart. in the Chair.

An Address by Mr. J. V. Thompson "To the Members of the Zoological Society, and the Zoologists of the United Kingdom in general," was read, soliciting such support, by subscription, as may enable him to continue, without further loss, his "Zoological Researches and Illustrations." This Address is printed, together with a list of the subjects of some of the succeeding Memoirs, on the cover of the Fourth Number of the Researches, which was at the same time laid on the table.

An Extract was read from a Letter addressed by Daniel Sharpe, Esq., to Mr. Bennett, in which the writer describes the luminous appearance of the ocean as observed by him on several nights during his passage to Lisbon. A considerable sparkling was visible in the water close under the vessel's side, particularly in the spray just thrown off from the bow, and also occasionally when a wave broke: it gradually vanished as the water became quieter. The appearance was that of a number of small sparks not brighter than the smallest stars. When a bucket full of the water was taken up, nothing was visible until it was stirred or shaken, when it was instantly filled with spangles, which disappeared as the water settled: the most elegant effect was when the waves or spray broke over the deck, which then became covered with stars for a few minutes. Mr. Sharpe states that he collected a great quantity in a glass, and examined them carefully with a microscope the next morning, in the expectation of observing minute *Crustacea*, &c., to which the appearance he describes has frequently been attributed. He could, however, detect nothing but an abundance of small fibres and shreds of, apparently, animal matter, and did not find even one entire animal. Hence he is disposed to infer that, in some instances at least, the phosphorescence of the sea arises from the quantity of particles of dead fishes &c. always floating on its surface; although he confesses himself unable to explain the reason why these shine only when the water is disturbed.

It was remarked that Commerson and others have attributed the phænomenon described to the putrefaction of animal matters: and M. Bory de St. Vincent has declared that marine *animalcula* take no share in it. Sir Joseph Banks, Dr. Macartney, and others, on the contrary, have referred it to the presence of marine animals, principally *Crustacea*; and the existence of such, as the cause of this appearance, has been recently insisted on by Mr. J. V. Thompson.

Dr.

Dr. MacCulloch has also attributed it to the latter cause; and states that every marine animal that he has examined is luminous. Assuming the observations of M. Bory de St. Vincent and those of Dr. MacCulloch to be equally correct in the instances which fell under their notice, it is worthy of inquiry whether any, and what, differences exist in the luminosity of the ocean, when it is occasioned by marine animals, or when it is owing to other causes.

Mr. Yarrell exhibited a female of the common *game Fowl* which had assumed the plumage of a male. The dull brown colour of the breast was varied by an intermixture of the jet black plumage peculiar to the male; the feathers of the neck and those on the sides of the tail were long, slender, hackled and bright in colour; all the tail feathers were more or less curved; and the spurs were half an inch in length. This bird very closely resembled the representation attached to Dr. Butter's paper on this subject in the third volume of the "Memoirs of the Wernerian Society." A portion of the body of the bird was also shown, the disease of the sexual organ pointed out, and its appearance contrasted with preparations of the same parts from healthy birds. The cause of this change in the external character is fully detailed in John Hunter's "Animal Economy," in the Wernerian Memoirs before mentioned, and in a paper by Mr. Yarrell, published in the "Philosophical Transactions" for 1827.

Mr. Vigors resumed the exhibition of the birds from the Himalayan Mountains, which he had commenced at the Meeting of the 23rd Nov.; and named and characterized the following apparently new species:

Alcedo guttatus. *Alc. cristatus, supra ater, maculis rotundis albis guttatim notatus; subtus albus; colli lateribus pectoreque atro maculatis.*

Statura *Alc. maximi.*

Muscipeta princeps. *Musc. capite, collo, dorso summo, alis, rectricibusque duabus mediis nigris; corpore inferiori, dorso imo, fasciâ latâ alarum, maculis paucis remigum secundariarum, rectricibusque lateralibus aurantio-coccineis; rostro fortiori.*

Longitudo circiter novem uncias.

Lanius erythropterus. Mas. *Lan. nuchâ dorsoque griseis; capite supra, alis, caudâque atris; corpore subtus, strigâ superciliari, remigumque apicibus albis; alis maculâ latâ rubrâ notatis.*

Fœm. *Capite griseo; dorso, alis, rectricibusque virescenti-olivaceo notatis; harum apicibus flavis.*

Statura *Lan. Collurionis.*

Parus monticolus. *Par. capite, collo, pectore, abdomine medio, alis, rectricibusque atris; genarum maculâ latâ nuchalique parvâ, tegminum remigum secundariarum rectricumque apicibus, et remigum primariarum rectricumque lateralium pogoniis externis albis; abdominis lateribus flavis.*

Staturâ paulo minor *Par. majori.*

Parus xanthogenys. *Par. capite cristato, gulâ, pectore, abdomine medio, strigâ utrinque colli, scapularium maculis, alis, cau-*

dâque atris, his albo notatis ; dorso scapularibusque virescenti-griseis ; genis, strigâ superciliari, maculâ nuchali, abdominisque lateribus flavis.

Statura præcedentis.

PARUS MELANOLOPHUS. *Par. griseus ; capite cristato pectoreque atris ; genarum, nuchæ, tegminumque alarum maculis albis ; remigibus rectricibusque fuscis ; maculâ sub alis rufâ.*

Staturâ *Par. atro* paulo minor.

PARUS ERYTHROCEPHALUS. *Par. supra pallidè brunnescenti-canus, subtus rufescenti-albus ; gulâ, strigâ superciliari, rectricumque lateralium pogoniis externis albis ; capite supra rufo ; strigâ latâ per oculos ad nucham extendente, thoraceque atris.*

Statura *Par. pendulini*, Linn.

FRINGILLA RODOPEPLA. *Fring. supra brunnea ; capite, nuchâ, dorsoque lineis fuscis rosaceoque nitore notatis ; strigâ utrinque superciliari, gulâ, thorace, maculis alarum, uropygio, corporeque subtus rosaceis.*

Longitudo circiter 7 uncias.

FRINGILLA RODOCHROA. *Fring. supra brunnea ; capite, nuchâ, dorsoque lineis fuscis, illo rosaceo tinctis ; fronte, strigâ utrinque superciliari, gulâ, pectore, corpore subtus, uropygioque rosaceis ; alis immaculatis.*

Longitudo circiter $5\frac{1}{2}$ uncias.

CARDUELIS CANICEPS. *Card. brunnescenti-canus ; alis caudâque nigris ; circulo angusto frontem rictum gulamque circumcingente coccineo ; fasciâ alarum aureâ ; thorace, maculis paucis alarum, uropygio, abdomine imo, crisso, rectricum externarum pogoniis internis, mediarumque apicibus albis.*

Statura *Card. communis.*

PICUS HYPERYTHRUS. Mas. *Pic. corpore supra nigro, albo-maculato, subtus rufescenti-badio ; capite crissoque coccineis ; strigâ utrinque per oculos extendente albâ ; mandibulâ superiori nigrâ, inferiori albâ.*

Fœm. *Capite nigro albo-lineato.*

Statura *Pic. medii*, Linn.

COLUMBA LEUCONOTA. *Col. capite canescenti-atro ; crisso caudâque nigris ; nuchâ, corpore subtus, dorso medio, caudæque fasciâ latâ mediâ, albis ; tegminibus alarum vinaceo-canis ; dorso superiori scapularibusque brunnescenti-canis ; remigibus, fasciisque alarum brunnescenti-fuscis.*

Statura *Col. Palumbi*, Linn.

OTIS HIMALAYANUS. *Ot. niger ; alis albis ; dorso medio scapularibusque pallido-rufo brunneoque variegatis ; dorso imo pallido-rufo undulatim sparso ; cristæ collique plumis anterioribus et posterioribus confertis, elongatis.*

Mr. Vigors exhibited a living specimen of a new species of *Ground Parrakeet*, which had lately been added to the Society's Menagerie. Its native place was not ascertained : but from the more graduated form of the tail and the plumbeous colour of the bill, it was conjectured to have belonged to some of the Australian islands ; the *Parrakeets*

rakeets of which are distinguished by these characters from the allied groups of the same genus *Platycercus* of the Australian continent. The lively and active gait of this bird, as distinguished from the slow and climbing motions of the *Parrots* in general, was particularly noticed. Its colour was a uniform green without any markings. It was named and characterized as

PLATYCERCUS UNICOLOR. *Plat. corpore viridi concolore; rostro basi plumbeo, apice nigro.*

Mr. Vigors also exhibited a specimen of the *lineated Pheasant* of Dr. Latham [*Gen. Hist.*, *vol.* viii. *p.* 201. *sp.* 14.] which had lately been received from the Straits of Malacca. The bird accorded accurately with Dr. Latham's description, as communicated to him by Dr. Buchanan from a living specimen in an aviary in India, and afforded evident proof of being a distinct and strongly marked species. It may be characterized as follows:

PHASIANUS LINEATUS, Lath. MSS. *Phas. supra cano-griseus; fasciis gracilibus nigris undulatus; capite, cristâ elongatâ, gulâ, collo anteriori, corporeque infra nigris; abdominis laterum plumis in medio lineis gracilibus albis notatis; caudâ albo nigroque undulatim sparsâ.*

A large collection of *Insects*, of various orders, presented to the Society by Dr. Leach, was exhibited. It was chiefly formed in the neighbourhood of Rome and Florence; and notes were appended to the greater number of the species, indicating the precise locality of each, the time of its appearance, its food, comparative rarity, &c.

The attention of the Committee having been directed to that part of the Minutes of the Council which referred to the preparation of a Report on the animals which it was desirable for the Society to import:

It was resolved,

That Sir Thomas Phillipps, Mr. Vigors, Mr. Owen, Mr. Cox, and Mr. Bennett, be requested to prepare, for the consideration of the Committee at its next Meeting, a Report on the animals for the importation of which the Council should be recommended to take measures.

The following Resolution was also submitted to the Committee, and adopted:

Resolved,

That Mr. Morgan, Mr. Yarrell, and Mr. Vigors, be requested to prepare a series of questions on points relating to the generation, gestation, parturition, and suckling of the *Kangaroo*, in order that the same may be submitted to the Council, with a request that directions may be given to the Superintendents of the Society's establishments to obtain information thereon.

XXVI. *In-*

XXVI. *Intelligence and Miscellaneous Articles.*

ON THE SPONTANEOUS INFLAMMATION OF POWDERED CHARCOAL.

M. AUBERT, colonel of artillery, has made numerous experiments on the above subject: he states that charcoal when very finely powdered has the appearance of an unctuous liquid, and occupies only one third the space of sticks of charcoal of about six inches long.

In this state of division, it absorbs air much more rapidly than when it is in sticks; still however the absorption goes on slowly, requiring several days for completion; it is accompanied with the disengagement of heat, which is to be regarded as the true cause of the spontaneous combustion of the charcoal; the heat is equal to about 350° of Fahrenheit. The inflammation occurs towards the centre of the mass, at about five or six inches beneath the surface; the temperature is constantly higher in this place than in any other; there must consequently exist towards the edges of the mass a descending current of air, which tends towards the centre, and bebecomes vertical, without penetrating towards the lower parts of the mass, where the temperature is but little raised. It is on this account that a portion only of the charcoal appears to produce the phænomena; the remainder serves as an isolating substance, and preserves the heat in the centre.

The variations of the barometer, thermometer and hygrometer do not appear to have any sensible influence upon the spontaneous inflammation of the charcoal; if such influence exists, the experiments have not been sufficiently multiplied to prove it.

Black charcoal, strongly distilled, heats and inflames more readily than imperfect or slightly distilled charcoal.

The black distilled charcoal, which is the most inflammable, ought to be in masses of about 60 pounds at least, that spontaneous inflammation may take place; with less inflammable charcoal the inflammation occurs only in larger masses. In general the inflammation occurs more certainly and readily, as the time is short between the carbonization and powdering. Air is not only necessary for the spontaneous inflammation, but there must be free access of it at the surface; the weight which the charcoal acquires to the moment of its combustion, is derived not merely from the privation of air, but partly to the absorption of water. During trituration the air undergoes no change from the charcoal; nor does it suffer any up to the moment of its inflammation.

Sulphur and nitre, added to the charcoal, take away its property of inflaming spontaneously; still however there is absorption of air and heating; and although the increase of temperature is not very great, it is prudent not to leave these mixtures in too large masses after trituration.—*Ann. de Chim.*, *Sept.* 1830.

ON PURE IODIC ACID AND THE DETECTION OF THE VEGETABLE ALKALIES.

M. Serullas has found

1st, That when perchloride of iodine is mixed with water, there results iodic and muriatic acid from the decomposition of the water.

2nd, That the solid perchloride of iodine, previously slightly washed with water, or still better with a solution of the perchloride, when mixed with æther or concentrated alcohol, is suddenly converted, by the elements of water, into muriatic acid, which remains in solution, and very pure iodic acid, which is precipitated, on account of its insolubility in alcohol.

3rd, That oxide of silver, agitated in proper quantity in a solution of perchloride of iodine, seizes only the muriatic acid, leaving free and pure iodic acid in solution.

4th, That iodic acid (and the solution of perchloride of iodine, on account of the iodic acid which it contains, produces the same effect) combines rapidly with the vegetable alkalies, forming very acid compounds with these bases, which are almost insoluble in concentrated alkohol; this affords a method of discovering very small quantities of these alkalies in solution in alcohol, which is a condition in which it is easy to place them.—*Ann. de Chim., Sept.* 1830.

PARA-TARTARIC ACID.

M. Dulong communicated to the Academy of Sciences a letter from M. Berzelius, relating to several chemical compounds, which are perfectly similar to each other in the nature and proportion of the elements of which they are composed; but are very different in their physical and chemical properties. M. Berzelius has paid particular attention to the new acid which M. Gay-Lussac has met with in tartar, and which has been called Thannic acid; M. Berzelius shows that this acid, which possesses very different properties from tartaric acid, gives by analysis a perfectly similar composition. It is also well known that common phosphoric acid, and that which has been recently calcined, and which has been called pyrophosphoric acid, offer very considerable differences in their properties; it is also the same with stannic acid (deutoxide of tin), accordingly as it is prepared by treating tin with nitric acid, or by decomposing the deutochloride, or fuming liquor of Libavius.

M. Berzelius, in order to connect all these observations, proposes to call those bodies *isomères* (of equal elements) which possess the same composition, and to add the Greek preposition *para* to that of the two bodies which occurs most rarely, and is obtained with most difficulty;—thus common phosphoric acid will be termed simply phosphoric acid, and the pyro-phosphoric will be termed para-phosphoric, and we shall have also tartaric acid and para-tartaric acid, stannic acid and para-stannic acid.—*Journ. de Pharm, Oct.* 1830.

ON THE CHLORIDES OF IODINE AND THE DETECTION OF THE VEGETABLE ALKALIES.

M. Serullas lately read a memoir on the above compounds before the

the Academy of Sciences, in which he states that the perchloride of iodine, when put into water, suddenly decomposes it, and occasions the formation of iodic and muriatic acid. When it is put into alcohol the same effects are produced; and as the iodic acid is insoluble in alcohol, its action affords a ready method of separating the two acids; the iodic acid is deposited in the state of a colourless crystalline powder; iodic acid is one of the most sensible reagents for detecting the presence of the vegetable alkalies, with which it combines to form compounds of very little solubility, so that, according to M. Serullas, the hundredth part of a grain of the alkali may be detected. These compounds, when dried, detonate strongly if heated much above the temperature of boiling water. —*Le Globe, Nov.* 11*th*.

CHLORIDE OF GOLD AND POTASSIUM, &c.

M. Berzelius finds this salt to consist of

Chloride of potassium . .	17·525
Gold	46·800
Chlorine	25·050
Water	10·625
	100·000

This salt crystallizes sometimes in striated prisms, truncated at the extremities, and sometimes in hexagonal plates; the colour is yellowish-orange, and the crystals effloresce very readily in dry air.

The chloride of gold and sodium consists of

Chloride of sodium . . .	14·466
Chloride of gold	76·002
Water	9·532
	100·000

This salt crystallizes in prisms of an orange-red colour; it does not part with its water of crystallization without at the same time losing chlorine.—*Ann. de Chim., Sept.* 1830.

VAUQUELIN'S PROCESS FOR OBTAINING CHROMIUM.

When an attempt is made to procure chromium by employing the oxide and charcoal, the operation never succeeds well, whatever may be the degree of heat to which the mixture is subjected. The chromic acid is more readily reduced than the oxide, and 72 parts yielded 24 parts of metallic chrominm. The muriate of chrome is that which succeeded best, and in the following manner:—Treat chromate of lead in fine powder with 4 or 5 times its weight of muriatic acid, until it is perfectly dissolved; then evaporate to dryness and dissolve the muriate of chrome by alcohol, that there may be no chloride of lead.

Evaporate again at a moderate temperature, to the consistence of a syrup, and make it into a mass with a sufficient quantity of oil and a little charcoal, to make it into a paste; put it in a small crucible, inclosed in another crucible filled with charcoal powder, and heat it in a good forge fire for about an hour.—*Ibid.*

CARBURET

CARBURET OF SULPHUR NOT DECOMPOSED BY ELECTRICITY.

According to M. Wöhler, the black deposit on the sides of the tubes, which M. Becquerel supposed to be carbon derived from the decomposition of carburet of sulphur by electricity, is merely sulphuret of copper produced from the sulphur in the sulphuret of carbon.—*Poggendorf's Annalen. Brewster's Journal, Jan.* 1831.

INFLUENCE OF THE AURORA BOREALIS ON THE MAGNETIC NEEDLE.

Mr. Sturgeon has mentioned, in his paper on the Aurora Borealis of Jan. 7th, as witnessed at Woolwich (p. 128 of our present Number), that he could not observe the slightest change of direction or disturbance in the magnetic needle, during the display of the Aurora. As this is a subject of much importance, we deem it improper to publish this result, without stating, at the same time, that M. Arago, at the Observatory of Paris, was also engaged on the evening of the 7th, in observations on both the horizontal and the dipping-needle, during the appearance of the Aurora; and that he found the former to be deranged $1° \ 6' \ 47''$ by the influence of that meteor, and the latter the enormous quantity of $21'$, the ordinary diurnal variation of the dip, at this season, scarcely exceeding $1'$. An account of M. Arago's observations will be found in the *Le National* of January 12th.

NITROUS ATMOSPHERE OF TIRHOOT.

Tirhoot is one of the principal districts in India for the manufacture of saltpetre; the soil is everywhere abundantly impregnated with this substance, and it floats in the atmosphere in such quantities, that during the rains and cold weather it is attracted from thence by the lime on the damp walls of houses, and fixes there in shape of long downy crystals of exceeding delicacy. From damp spots it may be brushed off every two or three days almost in basketsful. In consequence of all this, the ground, even in hot weather, is so damp, that it is extremely difficult either to get earth of sufficient tenacity to make bricks (the country being quite destitute of stones), or, when made, to find a spot sufficiently solid to sustain the weight of a house. Even with the greatest care the ground at last yields, and the saltpetre corrodes the best of the bricks to such a degree, that the whole house gradually sinks several inches below its original level. Houses built of inferior materials of course suffer much more; one, of which the inner foundations were of unburnt bricks, absolutely fell down whilst I was at Mullye, and the family in it escaped almost by miracle. My own house, which was not much better, sank so much, and the walls at bottom so evidently giving way, that I was compelled with extreme expense and inconvenience, to pull down the whole inner walls, and build them afresh in a more secure manner. From the same cause a new magazine which Government directed to be built, with an arched roof of brick-work, was, when complete, found so very unsafe, that it was necessary to demolish it entirely, and rebuild it on a new plan, with a roof of tiles. In such a soil it will easily be concluded that swamps and lagoons prevail very

very much, of course, mostly during the rains, and till the sun gathers power in the hot weather; and, in fact, what has been above so much insisted on, as to the two contrary aspects of the country with respect to vegetation, may, by a conversion of terms, be equally applied to the water on its surface. In the cold and dry weather it is comparatively scanty; in the rains it is superabundant: and as the rivers in this district are frequently found to change their situations, so, through a long course of time, it has resulted that hollow beds, being deserted by their streams, become transformed into what, during the rains, assume the appearance of extensive lakes, but in dry weather degenerate into mere muddy swamps, overgrown with a profusion of rank aquatic vegetations, particularly the gigantic leaves of the lotus, and swarming with every tribe of loathsome cold-blooded animals. Some of these lakes, during the height of the rains, communicate with their original streams, and thus undergo a temporary purification; but others receive no fresh supply except from the clouds, and of course their condition is by much the worse. Some of the conversions of a river-bed into a lake have occurred in the memory of the present inhabitants, or at least within one descent from their ancestors.—*Tytler on the Climate of Mullye, in Trans. Med. & Phys. Soc. of Calcutta*, vol. iv.—*Jameson's Journal, Jan.* 1831. p. 177.

ON THE OCCURRENCE OF CHALK-FLINTS IN BANFFSHIRE. BY JAMES CHRISTIE, ESQ., SEC. TO THE BANFF INSTITUTION.*

Some time ago I took the liberty of submitting for your inspection specimens of a quantity of flints found scattered and mixed with the water-worn stones and shingle along the shore of Boyndie Bay†, to the westward of Banff, and to state, that flints of a similar description are occasionally found to the eastward as far as Peterhead. I had not seen any organic remains in the flints of this part of Scotland, to enable me to form an opinion as to their being of the chalk-formation‡. Since that time I have met with abundance of flints on the hill or rising ground between Turiff and Delgaty Castle. The surface of the ground there is irregular, rising occasionally into hillocks, and sinking into hollows, filled with bogs and swamps. These hillocks are composed of a conglomerate or pebbly mass,

* At p. 381 of the last volume of this Journal, we noticed Mr. Christie's discovery of flints on the shore near Banff.—*Edit. Edinb. New Phil. Journ.*

† The flints sent me from Boyndie Bay are of the same description with those found near Delgaty. They contain traces of zoophytic organic remains.—*Edit. Edinb. New Phil. Journ.*

‡ Some years ago, while examining the geognosy of the vicinity of Peterhead, our attention was directed to the chalk-flints found in that neighbourhood, by previous information. We traced them extending over several miles of country, and frequently imbedded in a reddish clay, resting on the granite of the district. These flints contain sponges, alcyonia, echini, and other fossils of the chalk-flint, thus proving them to belong to the chalk formation, which itself will probably be found in some of the hollows in this part of Scotland.—*Edit. Edinb. New Phil. Journ.*

having

having a base or ground of white or gray colour, and apparently composed of decayed felspar, and very minute scales of mica or talc, or both, in which are imbedded rounded pebbles of grayish-white translucent quartz-rock. The quartz-pebbles are from the size of a pea to that of a hen's egg. This conglomerated mass is here and there alternated with or traversed by a white quartzy sand, with scales of mica. The whole conglomerated mass is mixed up with *flints* of various sizes and forms. The flints are yellow, brown, and gray, more or less translucent, often enveloped in a white siliceous opaque crust, and containing organic remains principally of sponges or alcyonia. In some flints the centre is hollow, and the walls of the cavity lined with calcedony. One of the hillocks has been opened to the depth of about fifteen or eighteen feet. The quartz-pebbles become more translucent the deeper the pit is opened; and the flints, which, at the surface of the ground, are generally of a brown colour, exhibit other tints in the interior of the bed. The hollows between the hillocks are destitute of pebbles and gravel, and have a clayey bottom. The direction of the hollows appears in general to run east and west. These hollows may perhaps have been scooped out, and the beds containing flints and pebbles of quartz carried off by some of those mighty inundations which have more than once swept over the face of nature.

As to the extent of the deposit, I can say but little: in one direction, I have traced it for nearly a mile, occasionally interrupted by the hollows. The point where the specimens were taken up is about half a mile distant from another patch, through which the ditch I formerly mentioned has been cast. At that point, also, the flints and quartz-pebbles, and other deposits, are the same as those already mentioned. The spot where these deposits are found is in the interior of the country, about ten miles from the sea, and is the highest ground in the neighbourhood. I have not been able to ascertain the depth of the bed, as the pit filled with water on digging down, and the water became thick with the clayey or chalky matter. The workmen, however, told me, that further down the hill they had met with a bed of white clay, and they believed the deposit of pebbles, flints, &c. rested on it.

I have never seen the chalk-formations, but, as I understand it, this deposit has many features of its upper strata. The flints are abundant throughout the whole, and I found them on the surface at a mile distant from the hillock where the specimens were taken from*.—*Edin. New Phil. Journ., Jan.* 1831.

* We trust Mr. Christie, and other members of the Banff Institution, will continue their researches in regard to these flints; for possibly the chalk-formation itself may be found *in situ* in this part of Scotland.—*Edit. Edinb. New Phil. Journ.*

NEW SCIENTIFIC BOOKS.

Just Published.

Account of the "Traité sur le Flux et Reflux de la Mer," of Daniel Bernouilli; and a treatise on the Attraction of Ellipsoids. By J. W. Lubbock, Esq. F.R.S.

In the Press.

A Geological Manual; by H. T. De la Beche, F.R.S. &c. In one volume, with numerous wood-cuts.

The Utility of the Knowledge of Nature considered; with reference to the Introduction of Instruction in the Physical Sciences, into the General Education of Youth: comprising, with many additions, the details of a Public Lecture on that subject, delivered at Hazelwood School, near Birmingham, on the 26th of October, 1830. By E. W. Brayley, jun. A.L.S., Lecturer on Natural Philosophy and Natural History, and Teacher of the Physical Sciences in Hazelwood School.

Preparing for Publication.

Mr. MacCulloch, Professor of Political Economy in the University of London, is preparing for publication, a Theoretical and Practical Dictionary of Commerce and Commercial Navigation. In one large volume, 8vo, with Maps, &c.

THE COMET.

Extracts of Communications from Mr. Herapath and Sir J. South to the Editor of The Times, *Jan. 25th, 28th, and 29th.*

On the 7th, at $6^h\ 30^m$ A. M., it was in 264° 11′ right ascension, and 12° 33′ south declination, from my observation. On the 9th, at $6^h\ 47^m$ A. M, it had 261° 59′ right ascension, and 12° 1′ south declination, by the observation at Kensington Observatory; and on the 18th I found it in 252° 18′ right ascension, and 9° 2′ south declination, at $5^h\ 43^m$ A. M. The time was apparent or solar in each case. On the 7th the head was white and brilliant, with a tail of between 1° and 2° at Cranford, and the comet equalled, as I conceived, stars of the second magnitude. To Sir James South, on the 9th, the head was very luminous, and the tail about 1° long; while to Mr. J. T., near Liverpool, on the 12th, the tail seemed 2°, or, as he informs me by letter, probably 3° long, the head being bright and the nucleus well defined. On the 18th the head appeared to me much less and more confused; but the tail had extended in length to full 3°, and was much more apparent. At these several epochs it was about 25°, 29°, and 47° distant from the sun.

From all these circumstances, it appears that the apparent motion of the comet is retrograde; that it crossed the ecliptic about the latter part of Capricorn, and is proceeding by a path rather concave towards the north, between the stars ζ and δ Ophiuchi, passing to the north of the former, and about $2\frac{1}{4}$° to the south of the latter, which it will reach on the 28th inst.; that its apparent motion is decreasing, and will probably before long cease, and at length become direct; that the comet has approached nearer to the sun, and most likely to the

the earth too; and though its motion is now increasing towards the north, in all probability it will finish by declining towards the south. From its great elongation, it would seem the true path of the comet is without that of Venus, and that it is either between us and the sun, or on the other side of the sun. In the former case, its real motion is direct, in the latter retrograde; but judging from the appearance of the body, I should think it is between us and the sun.

Whether this be the comet said in the *Morning Herald* to have been predicted by the Chinese, or that of 1770, which Mr. J. T. imagines it might be, or indeed any one of the comets which have yet appeared, the present observations are not sufficient to determine. However, its great elevation above the ecliptic, and its long train, which mark it for a comet of a long period, are not, I conceive, favourable to an identity with that of 1770.

On the 7th I find it was south about $20^h\ 21^m$ A. M., and rose about $20'$ after 5; on the 18th it was south $10'$ before 9, and rose at about $33'$ after 3; on the 30th it will be south about $8'$ after 7, and rise about half-past 1. Its place on the 18th differed, I see, only $13'$ in right ascension, and about half a degree in declination, from the place it should have had by my computations from the observations of Sir James South and myself on the 9th and 7th. Should it therefore proceed as it has, on the 25th, it will be in about $244°\frac{2}{3}$ds right ascension, and $6°\frac{2}{3}$ds south declination; and on the 30th, in $239°\frac{1}{4}$ right ascension, and $5°$ south declination: hence it may be easily found. Since the 18th I have not seen it.

Jan. 26.—I this morning saw the comet for the last time I expect that I shall see it. It is diminished in splendour wonderfully since the 18th. At that time it was beautifully brilliant, but a little after 5 this morning it was totally invisible to the naked eye. The great light of the moon, no doubt, had some influence in this; but at 6, and a quarter after, when the moon had been for some time down, it could be seen by the eye at intervals only, and then as a very small star, destitute of any of the appendages of a comet. Even when viewed through a telescope, with a power of about 30, both before and after the setting of the moon, it merely exhibited a nebulous appearance, without, as far as I could discover, any tail or well-defined nucleus.

From these circumstances it may easily be imagined, that it was impossible to ascertain its place by the sextant. As far as I could judge, it was very little to the right of a straight line joining ϵ Ophiuchi, and 17 or υ Ophiuchi, by Bode's Catalogue. It seemed to be better than one-third of the distance of these stars from υ, and not far from, but to the right of, a small star, I believe 16 Ophiuchi, which appeared in the field of the telescope. Its position appeared not to differ from the place my computation would have given it, except that I thought it was more to the south.

It is, however, evident that this body will no longer be a subject for even tolerably good instruments, but must be left to such powerful means as are possessed by the fixed observatories. One thing which surprises me is, that in so short a period as 19 days it should have

 had

had such unaccountable changes. On the 7th it was a brilliant comet, with a tail of from 1° to 2°, on the 12th from 2° to 3°, on the 18th at least 3°, and by the 26th it had sunk to a tailless and almost undiscoverable star. This excessively rapid rise and diminution of splendour is, to the best of my knowledge, a novelty in astronomy, and I presume must arise from some peculiarity in the comet's path round the sun, relative to that of the earth. It is therefore to be regretted that the weather has been so unfavourable as to preclude our daily tracing its successive and perhaps singular gradations.

I should now imagine this body must have passed its perihelion for some time, probably before my second or even my first observation. In this case the greater apparent length of its tail on the 18th may have been owing to its greater elevation above the plane of the ecliptic. However, I am anxious to know what has been seen of this body on the Continent; they have most likely had better opportunities of seeing it further south than we have had. JOHN HERAPATH.

The following is from *The Times* of Jan. 29:—

"It was observed here on Wednesday and this mornings. On the former occasion, it might, by a person knowing well where to look for it, be with difficulty detected by the unassisted eye; this morning, certainly not. In either instance, under very slight illumination of the field, it became invisible.

"At 14^h 16^m 38^s sidereal time of Tuesday the 25th, its right ascension was 16^h 14^m 46^s and $\frac{3}{10}$ths; and its southern declination was 6° 36^m and 6^s; whilst at 14^h 31^m 16^s and $\frac{6}{10}$ths, sidereal time of yesterday, the 27th, its right ascension was 16^h 4^m 6^s and $\frac{2}{10}$ths; and its southern declination 5° 45^m and 34^s. Hence its daily diminution of right ascension, in time, is about 5^m 20^s and of southern declination about 25^m 15^s. J. S."

Observatory, Kensington, Jan. 28, 1831.

LUNAR OCCULTATIONS.

Occultations of Planets and fixed Stars by the Moon, in February 1831. Computed for Greenwich, by THOMAS HENDERSON, *Esq.; and circulated by the Astronomical Society.*

1831.	Stars' Names.	Magnitude.	Ast. Soc. Cat. No.	Immersions. Sidereal time.	Immersions. Mean solar time.	Immersions. Angle from North Pole.	Immersions. Angle from Vertex.	Emersions. Sidereal time.	Emersions. Mean solar time.	Emersions. Angle from North Pole.	Emersions. Angle from Vertex.
				h m	h m	°	°	h m	h m	°	°
Feb. 1	k^4 Virginis	6	1500	13 2	16 16	81	83	14 19	17 32	227	243
19	48 Tauri	6	468	4 41	6 46	108	119	5 54	7 58	278	303
	γ Tauri	3·4	478	6 55	8 58	114	147	8 1	10 5	266	305
	71 Tauri	5·6	503	9 59	12 2	69	109	10 48	12 51	303	341
	θ^1 Tauri	5	510	11 1	13 4	136	174	11 39	13 42	236	272
	θ^2 Tauri	5·6	511	10 57	13 0	114	152	11 45	13 48	258	293
20	111 Tauri	6	640	9 52	11 51	52	93	10 37	12 37	312	353

LIST

LIST OF NEW PATENTS.

To J. Revere, Weybridge, Surrey, M.D. for a new and improved method of protecting iron chain cables, iron boilers, and iron tanks, from the corrosion produced upon them by the action of water.—Dated the 27th of November 1830.—2 months allowed to enrol specification.

To W. Church, Haywood House, Warwickshire, esquire, for certain improvements in apparatus applicable to propelling boats and driving machinery by the agency of steam, parts of which improvements are also applicable to the purposes of evaporation.—29th of November.—6 months.

To R. Dalglish, junior, Glasgow, calico-printer, for improvements in machinery or apparatus for printing calicoes and other fabrics.—6th of December.—6 months.

To H. Blundell, Kingston-upon-Hull, merchant, for improvements in a machine for grinding or crushing seeds and other oleaginous substances, for the purpose of abstracting oil therefrom, and which machine, with certain improvements or alterations, is applicable to other useful purposes.—6th of December.—6 months.

To R. Edwards, Dewsbury, Yorkshire, leather- and flock-seller, for an improvement on, or substitute for, glass, sand, emery, and other scouring-paper or substances.—6th of December.—6 months.

To S. Brown, Billiter-square, London, commander in the Royal Navy, for certain improvements in the means of drawing up ships and other vessels from the water on land, and for transporting or mooring ships, vessels, and other bodies, on land, from one place to another.—6th of December.—6 months.

To J. G. Lacy, Camomile-street, London, gun-manufacturer; and S. Davis, East Smithfield, gun-lock maker, for a certain improvement or improvements in the construction of guns and fire-arms.—6th of December.—6 months.

To J. Dixon, Wolverhampton, and J. Vardy, of the same place, for certain improvements in cocks for drawing off liquids.—13th of December.—2 months.

To T. Walmsley, Manchester, manufacturer, for improvements in the manufacture of cotton, linen, silk, and other fibrous substances, into a fabric or fabrics applicable to various useful purposes.—13th of December.—6 months.

To W. Needham, Longour, Staffordshire, gentleman, for certain improvements in machinery for spinning, doubling, and twisting, silk and other fibrous substances.—13th of December.—6 months.

To S. Parlour, Croydon, Surrey, gentleman, for certain improvements on lamps, which he denominates "Parlour's Improved Table Lamps."—13th of December.—2 months.

To J. L. Benham, Wigmore-street, Middlesex, ironmonger, for certain improvements on shower and other baths. Communicated by a foreigner.—13th of December.—6 months.

To R. Witty, Basford, in the parish of Wolstanton, Staffordshire, engineer, for certain improvements in apparatus for propelling carriages, boats, or vessels, and for other purposes, by the power of steam.—13th of December.—6 months.

Meteoro-

METEOROLOGICAL OBSERVATIONS FOR DECEMBER 1830.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·45. Dec. 15. Wind W.—Min. 28·86. Dec. 9. Wind S.E.
Range of the mercury 1·59.
Mean barometrical pressure for the month .... 29·607
Spaces described by the rising and falling of the mercury............ 8·130
Greatest variation in 24 hours .—Number of changes 22.
Therm. Max. 52°. Dec. 6. Wind S.E.—Min. 16°. Dec. 24. Wind N.
Range 36°.—Mean temp. of exter. air 38°·26. For 29 days with ☉ in ♐ 41·53
Max. var. in 24 hours 20°·00.—Mean temp. of spring-water at 8 A.M. 51·58

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the morning of the 29th ... 92°
Greatest dryness of the atmosphere, in the afternoon of the 24th... 59
Range of the index 33
Mean at 2 P.M. 74°·4.—Mean at 8 A.M. 80°·8.—Mean at 8 P.M. 78·7
—— of three observations each day at 8, 2, and 8 o'clock .... 78·0
Evaporation for the month 0·80 inch.
Rain in the pluviameter near the ground 2·430 inches.
Prevailing wind, N.W.

Summary of the Weather.

A clear sky, 2½; fine, with various modifications of clouds, 12; an overcast sky without rain, 10½; foggy, 1; rain, 5.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
16	4	31	0	14	10	18

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
5½	5½	3	3½	1½	2½	3	6½	31

General Observations.—This month has been generally wet and windy, and cold from the 10th to the 28th. In the night of the 5th a hard gale blew here from the South-east with rain, and there was a considerable depression of the mercury in the barometer. At Plymouth serious damage was done among the shipping, and many lives were lost during the gale from the same quarter: many merchant brigs were driven on shore, broken to pieces, and their cargos destroyed.

Early in the morning of the 17th an inch in depth of snow fell here, which disappeared by the evening: there were also sprinklings of snow on the following morning.

On the 21st the *maximum* temperature occurred in the night, and was followed by a little rain and wind from the South-west. In the afternoons of the 23rd and 24th it again snowed. The icy efflorescences which accumulated pretty thick on the inside of the windows in the night of the 23rd, did not dissolve during the following day, even in rooms with fire. A Fahrenheit's thermometer placed on the ground in the night of the 24th, receded to fourteen degrees, and to sixteen degrees in the nights of the 23rd and 25th. There was a difference of twenty-five degrees in the *maximum* temperatures of the 22nd and 24th! which was certainly a very great change in forty-eight hours. About this time a heavy fall of snow took place at Limerick in Ireland, which was succeeded by hard frost. In the night of the 26th half an inch in depth of snow fell.

The mean temperature of the external air this year (1830) is a quarter of a degree lower than that of the coldest year since 1816.

The

The atmospheric and meteoric phænomena that have come within our observations this month, are one solar and four lunar halos, nine meteors, four rainbows, five auroræ boreales, and ten gales of wind, or days on which they have prevailed, namely, two from the North-east, one from the East, two from the South-east, two from the South, and three from the South-west.

Auroræ Boreales.—In the evening of the 11th instant, a bright aurora borealis appeared at half-past eight, between an opening in a black cloud in the northern horizon. By 2 A.M. the cloud had dispersed, when the aurora was again seen with increased brightness, and as a segment cut off by the horizon, occupied a space of seventy degrees, from which emanated several flame-coloured perpendicular columns, some of which were two degrees wide, and thirty degrees in altitude. In half an hour after, they were succeeded by others, which ultimately exhibited red and purple tints, with an inclination to the horizon. Many persons in the country saw the aurora about this time, and described it as having a very awful appearance, from a mixture of the colours.

12th. An aurora borealis appeared from 6 till 10 P.M. and extended from North-north-east to North-west. The altitude of its arch was about eight degrees, and four meteors appeared over it.

13th and 14th. Faint auroræ appeared throughout the nights, much the same in height and extent as the one on the 12th.

25th. An aurora borealis appeared in the moonlight, from seven o'clock till after midnight, whose arch of light in the early part of the night extended from North-north-east to West-north-west, and many coloured columns rose from it. At half-past eleven, coruscations, just perceptible in the lunar light, emanated from the aurora, and it soon after sunk beneath the horizon.

REMARKS.

London. — December 1. Hazy. 2. Cloudy and cold. 3, 4. Drizzly. 5. Fine. 6, 7. Cloudy. 8. Overcast: rain at night. 9. Heavy rain in the morning, and at night. 10. Cloudy: clear, with frost, at night. 11. Fine. 12. Cold and cloudy; at night clear and frosty. 13, 14. Fine, with frost. 15. Foggy, with slight rain. 16. Foggy in the morning: showers: sharp frost at night. 17. Sleet. 18. Cloudy and cold, with some snow. 19. Fine in the morning: rain, with strong wind at night. 20—22. Fine. 23—26. Severe frost, with some snow. 27, 28. Overcast. 29. Frosty: fog in the morning: clear at night. 30. Fine. 31. Boisterous in the morning: fine at night.

Penzance. — December 1. Fair. 2. Rain. 3. Fair: misty. 4. Fair: showers. 5. Fair: stormy: rain. 6. Fair: rain. 7. Fair. 8. Fair: rain. 9. Rain. 10. Showers, hail, and rain. 11. Fair: showers. 12. Showers. 13, 14. Clear. 15, 16. Fair. 17. Rain: fair. 18, 19. Clear. 20—22. Showers. 23. Showers, hail, and rain. 24, 25. Snow. 26. Clear. 27. Showers, hail, and rain. 28, 29. Showers. 30. Rain. 31. Clear.

Boston. —December 1—8. Cloudy. 9, 10. Cloudy: rain A.M. and P.M. 11. Fine. 12. Snow. 13. Fine. 14. Cloudy. 15. Cloudy: rain A.M. and P.M. 16. Fine. 17. Rain. 18. Snow. 19. Fine. 20. Stormy: rain P.M. 21—23. Fine. 24. Cloudy and stormy: snow P.M. 25. Cloudy: snow P.M. 26. Fine. 27, 28. Cloudy. 29. Fine. 30, 31. Cloudy: snow melted.

Meteoro-

Meteorological Observations made by Mr. THOMPSON *at the Garden of the Horticultural Society at Chiswick, near London; by Mr.* GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1830.	Barometer. London. Max.	Barometer. London. Min.	Barometer. Penzance. Max.	Barometer. Penzance. Min.	Barometer. Gosport. Max.	Barometer. Gosport. Min.	Barometer. Boston $8\frac{1}{2}$ A.M.	Thermometer. London. Max.	Thermometer. London. Min.	Thermometer. Penzance. Max.	Thermometer. Penzance. Min.	Thermometer. Gosport. Max.	Thermometer. Gosport. Min.	Thermometer. Bost. $8\frac{1}{2}$ A.M.	Wind. Lond.	Wind. Penz.	Wind. Gosp.	Wind. Bost.	Evap. Gosp.	Rain. Lond.	Rain. Penz.	Rain. Gosp.	Rain. Bost.
Dec. 1	30·049	30·039	29·90	29·90	29·98	29·97	29·70	42	38	52	45	44	39	41	E.	SE.	NE.	calm	...	...	...	...	...
2	29·908	29·723	29·60	29·55	29·78	29·63	29·60	39	35	53	47	43	38	40	SE.	SE.	E.	calm	...	0·11	0·310	0·025	...
3	29·677	29·635	29·50	29·50	29·60	29·54	29·30	38	33	52	45	41	39	40	E.	SE.	NE.	E.	0·10	·01	[illegible]	...	...
4	29·854	29·785	29·70	29·70	29·80	29·73	29·41	40	36	51	46	44	40	38·5	NE.	SW.	NE.	calm	...	·04	·040	...	...
5	29·791	29·443	29·60	28·90	29·72	29·36	29·40	42	32	50	43	47	42	38	SE.	SE.	SE.	calm	...	...	·730	·340	...
6	29·158	29·120	28·65	28·60	29·06	29·00	28·90	45	50	52	45	52	49	43	SE.	SE.	SE.	N.	·10	...	·430	·035	...
☾ 7	29·239	29·166	29·20	28·90	29·14	29·07	28·90	48	44	52	48	51	45	45	E.	NE.	E.	E.	...	·01	...	·080	...
8	29·228	29·188	29·20	29·05	29·21	29·16	28·93	45	42	51	47	50	43	45	E.	SE.	NE.	calm	...	·30	·790	·650	...
9	28·930	28·910	29·00	28·90	28·91	28·86	28·70	49	42	47	41	52	41	43·5	E.	NE.	SE.	calm	·08	·18	·370	·510	...
10	29·227	29·059	29·30	29·25	29·28	29·10	28·62	44	31	47	41	45	38	42	NW.	NW.	NW.	NW.	...	...	·100	...	0·34
11	29·360	29·328	29·40	29·40	29·38	29·36	28·92	46	28	47	41	46	32	37	W.	SW.	W.	calm	...	...	...	·005	·07
12	29·993	29·469	30·05	29·55	29·90	29·48	28·90	41	29	45	38	41	29	35	N.	N.	N.	NW.	·09	...	·110	...	...
13	30·403	30·238	30·20	30·20	30·35	30·20	29·83	37	24	45	32	36	30	29	N.	NE.	NW.	NW.	...	...	...	...	...
14	30·444	30·386	30·20	30·20	30·42	30·37	29·94	41	30	47	35	44	34	34	W.	SW.	W.	calm	...	...	...	...	...
● 15	30·466	30·373	30·40	30·40	30·45	30·35	30·10	40	33	50	39	44	34	37	SW.	SW.	W.	calm	·07	·10	...	·010	...
16	30·411	30·367	30·30	30·20	30·34	30·32	30·00	37	23	51	43	38	29	37	NE.	NE.	NE.	calm	...	·18	...	...	·44
17	30·099	30·000	30·05	30·00	30·04	29·96	29·63	39	32	51	40	40	31	35	N.	NE.	NW.	NW.	...	·04	·145	·160	·15
18	30·228	30·212	30·20	30·20	30·20	30·15	29·86	39	30	47	35	38	31	33·5	N.	E.	N.	NW.	·09	·02	...	...	...
19	30·238	29·624	30·18	30·14	30·15	29·68	29·80	45	31	48	32	45	35	29	SW.	NE.	SW.	calm	...	...	...	·020	...
20	29·735	29·550	29·84	29·80	29·74	29·55	29·14	44	31	47	34	44	32	38	NW.	N.	N.	NW.	...	...	·130	...	...
21	29·895	29·757	30·00	29·90	29·88	29·79	29·50	48	34	48	42	45	41	34	W.	NW.	NW.	calm	·08	...	·030	·015	·26
☽ 22	29·627	29·391	29·80	29·70	29·64	29·45	29·07	50	32	50	43	50	33	34	W.	NW.	SW.	calm	...	·05	...	·020	...
23	29·590	29·479	29·70	29·68	29·53	29·50	29·07	33	18	42	38	38	18	33	NW.	NW.	NW.	NW.	...	...	·080	...	...
24	29·508	29·358	29·62	29·40	29·47	29·33	29·13	26	10	36	29	25	16	21	NW.	NE.	N.	NW.	·07	...	...	...	...
25	29·362	29·306	29·40	29·35	29·35	29·27	28·96	27	12	36	27	25	18	23.5	W.	NE.	NW.	NW.	...	...	...	...	...
26	29·378	29·257	29·35	29·20	29·34	29·21	29·07	32	24	40	25	32	20	27	SW.	SE.	N.	NW.	...	...	...	·060	...
27	29·237	29·168	29·10	29·10	29·14	29·10	28·97	33	29	42	34	38	34	27	SE.	NW.	SE.	calm	·05	·40	1·100	·280	...
28	29·566	29·112	29·50	29·20	29·45	29·11	28·92	32	21	45	33	38	30	34	SW.	NW.	NW.	calm	...	·10	0·160	...	...
○ 29	29·727	29·699	29·60	29·60	29·68	29·66	29·35	33	28	45	35	47	38	28	NW.	W.	S.	calm	...	...	·380	·130	...
30	29·527	29·253	29·20	28·90	29·36	29·20	29·25	53	40	50	38	46	44	34	E.	SE.	E.	calm	...	...	·410	·060	...
31	29·584	29·278	29·65	29·60	29·62	29·30	28·80	48	26	46	40	48	32	45	SW.	NW.	SW.	S.	·07	...	...	·030	·09
	30·466	28·910	30·40	28·60	30·45	28·86	29·27	53	10	53	25	52	16	35·5					0·80	1·54	5·315	2·430	1·35

THE

PHILOSOPHICAL MAGAZINE

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ANNALS OF PHILOSOPHY.

[NEW SERIES.]

MARCH 1831.

XXVII. *On the Volatility of Oxalic Acid.* *By* Edward Turner, *M.D. F.R.S. L., & E., Sec. G.S. Professor of Chemistry in the University of London**.

THE object of this notice is to communicate a few facts respecting the volatility of oxalic acid. It is stated in chemical works, that when this acid is exposed to the destructive distillation, part escapes decomposition and is sublimed, being deposited as a white sublimate in the neck of the retort; but whether this appearance is owing to real volatility, or is an instance of that spurious kind of sublimation, exemplified in the ascent of boracic acid along with aqueous vapour, and in the removal of fused chloride of silver when a current of hydrogen gas is passing rather rapidly over its surface, does not seem to have been fully determined. Oxalic acid, in consequence, is not generally regarded as volatile, except at a temperature sufficiently high for producing its decomposition.

Having been accidentally led to investigate this point, I found that oxalic acid may be sublimed at a very moderate temperature, even so low as 212° Fahr., without undergoing any chemical change, except that the common crystals lose two-thirds, corresponding to two equivalents, of their water of crystallization. When 63 parts of the common crystals are placed in a water-bath, efflorescence rapidly ensues, and 17·31 parts, somewhat less than two equivalents, of water are expelled. If the effloresced mass is then removed from the fire and exposed to the air, it speedily recovers from the atmosphere precisely the quantity of water which it had lost; but if it be still kept in the water-bath, the surface of the acid,

* Communicated by the Author.

instead of remaining pulverulent, becomes covered with numerous minute acicular crystals, and an acrid vapour rises, which condenses on cold surfaces in the form of needles. This vapour is accompanied with a small quantity of moisture, which completes the two equivalents of water required to be withdrawn, in order to constitute the sublimed acid.

The sublimation of oxalic acid at 212°, though sufficient both to occasion loss in analysis, and to establish the fact of volatility, is too slow for affording a supply of the sublimed acid. A convenient process for this purpose is the following: About half an ounce or an ounce of oxalic acid, purified by repeated crystallization, is dried in a rather deep evaporating basin, exposed on the sand-bath to a temperature of about 350° or 400° Fahr.: as soon as sublimation commences, the vessel should be covered with a layer of smooth filtering paper, on which is laid a fold of common blotting-paper, and both are pressed tight upon the edge of the basin by means of another and somewhat larger capsule, placed with its convexity downwards, and containing cold water or ice. During this rapid sublimation some of the acid is decomposed, and the water derived from this source is absorbed by the coarse outer fold of paper; while the acid is condensed on the smooth paper below, and gradually falls down upon the sides of the dish. At intervals of about an hour the apparatus should be removed from the fire, and the sublimed portions, while still warm, be brushed away with a feather, and quickly secured in a well-stoppered bottle.

Sublimed oxalic acid, as thus procured, is commonly in the form of minute shining acicular crystals; but I have occasionally obtained it in slender prisms half an inch long, possessed of considerable lustre and transparency. On exposure to the air it becomes dull and opaque from the absorption of moisture, 45 parts or one equivalent of the sublimed acid rapidly acquiring two equivalents of water, and thus regaining its original constitution. This water is again completely expelled by a temperature of 212°. The vapour of the acid is very pungent, exciting cough and sneezing more readily than the fumes of nitric or muriatic acid.

Sublimed oxalic acid rises slowly, as already mentioned, at 212°. As the temperature increases, the sublimation becomes more rapid; and if the heat does not exceed 300° or 330°, the acid sublimes entirely without decomposition. At 360° the sublimation is very free; between this point and 400° it sublimes rapidly; and at 414° it fuses and enters into brisk ebullition. At temperatures exceeding 330° more or less of the

subliming

subliming acid, as the heat is more or less intense, suffers decomposition; a change immediately indicated by the appearance of water.

The facts already mentioned leave little doubt of sublimed oxalic acid consisting of 36 parts or one equivalent of the anhydrous acid, and 9 parts or an equivalent of water. The correctness of this opinion was proved by analysis, the oxalic acid being precipitated with lime, and its quantity inferred in the usual manner by decomposing the resulting oxalate of lime. The sublimed acid, also, is readily decomposed by concentrated sulphuric acid, yielding abundance of gas, which consists of exactly equal measures of carbonic oxide and carbonic acid. When neutralized with potash and ammonia it yields crystals similar to the well-known oxalates of those alkalies; and the crystals obtained from a solution of the sublimed acid in pure water, were measured by Mr. Miller of St. John's College Cambridge, and found identical with the crystals of the common acid. These facts leave no doubt concerning the nature and constitution of the sublimed acid.

Before concluding this notice, I may add a few remarks on the solubility of ordinary oxalic acid in water, concerning which the statements of different authors are very discordant. The solvent power of water increases rapidly with the temperature. A hot solution of oxalic acid was set aside for twenty-four hours, when the clear liquid, kept at the temperature of 50° Fahr., was decanted from the crystals which had been deposited. This solution consisted of one part of crystallized acid and about 15·5 of water. The experiment was repeated by putting the pulverized crystals into water at 50°, agitating repeatedly during twenty-four hours, and then decanting the solution from the undissolved acid. The ratio of the ingredients was almost exactly the same as that above stated. Similar observations were made with water at 57°Fahr., of which 9·5 parts dissolve one of the crystallized acid.

Crystallized oxalic acid dissolves in almost an unlimited quantity in water kept at 212° by immersion in boiling water. If the acid solution is kept boiling by the direct application of fire, the temperature rises considerably above 212°, and the quantity of the crystallized acid dissolved is then unlimited. This is not surprising; since the crystals fuse in their water of crystallization at about 220° Fahr.

I may also add the following observations on the degree of permanence of crystallized oxalic acid. When the crystals are kept for some hours under a bell-jar, with quick-lime, at a temperature not higher than 50° or 55°, they contain all their water of crystallization, consisting of one equivalent of real

 oxalic

oxalic acid and three equivalents of water. If then exposed to a damp air, they increase slightly in weight by absorbing water hygrometrically, and its extent varies with the humidity of the atmosphere. In dry air at 70° Fahr. the crystals lose some of their water of crystallization, and effloresce on the surface. The efflorescing temperature is thus very little above the ordinary heat of summer.

XXVIII. *On the relative Hardness of Road Materials.* By B. Bevan, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I AM not aware of any published experiments on the relative hardness of road materials; and having for my own use examined a considerable variety of substances, as to their power of withstanding the percussion of a given weight, falling a few inches, I take the liberty of sending the results for your Magazine, if you think them sufficiently interesting. They were chiefly made in 1825, and the weight used was of cast-iron, falling upon the several specimens broken to the ordinary size adopted in modern roads, resting upon stone, or upon iron.

If the weather to which these materials were exposed had no effect towards their destruction, the table hereby given would nearly express their relative value for the purpose of supporting the wear of a road. Such of the articles, therefore, which resist the action of frost and atmospheric moisture, and have the highest numbers, will be found the most valuable.

Remaining, yours truly, B. Bevan.

Mount Sorrel sienite	100
White marble	37, 31
Chert pebbles, much used in Middlesex*	34, 27, 52, 56, 55, 65
Quartz pebble in Bedfordshire gravel	70
Ferruginous sandstone of Bedfordshire	20, 42
Hurlock, from lower chalk	10
Chalk	3
Granite, Scotch	110
Flint, yellow	33, 26
Greenstone or basalt, Quittlehill, near Coventry	110
Sandstone, soft	13, 6
Tile fragment	20
Gritstone, near Brixworth, Northamptonshire	48, 60
Limestone, near Bradwell, Bucks.	5

* These pebbles, we believe, are merely rolled chalk-flints, altered in colour by the protoxide of iron contained in them having been converted into peroxide.—Edit.

Dry

Dry clay	12
Flint, black	11, 30
Portland stone, hard	14
Quartz, white	56
Blue pebble, like Rowley rag	105, 110
Coarse limestone, near Stilton, Huntingdonshire	60
Gritstone on road, near Leeds	100, 115
Yorkshire paving-stone	20
Ketton, hard	20
Tetternhoe	4
Chert [?] from hills in Devonshire and Cornwall	57
Gray wether of Hertfordshire and Wiltshire	18
Grit of upper bed, Collyweston, near Stamford, Lincolnshire	40
Second bed, do.	100
Slate at do.	50
Stockton limestone, Warwickshire, (lias)	45
Newbold-on-Avon do.	36
Limestone of Stoke Cruerne, Northamptonshire	35

The steady pressure, without percussion, required to crush a piece of the marble weighing $\frac{1}{4}$ oz. = 600 lbs.

To crush the gray flint of 1·2 oz. weight = 2000 lbs.

To crush rolled white quartz pebble 2 oz. = 3400 lbs.

B. B.

P.S. To-day we have summer weather. At half-past three this morning, in clear starlight, the exposed thermometer was at ... 48°

At half-past seven in the morning ... 49°

At half-past one in the day ... 60°

At half-past five this afternoon ... 54°

The larks and other spring birds are singing; and the yellow butterfly is in full action. B. B.

Leighton Bussard, Feb. 10th, 1831.

XXIX. *Observations on a Species of Muscæ Volitantes apparently existing in the Aqueous Humour of the Eye.* By Thomas Batchelor, *Esq.**

AMONG the numerous defects and diseases to which the component parts of the eye are subject, accidental circumstances have led me to investigate several, which appear to have their seat in the humours; and which, as far as I can learn by inquiries among medical men, are not very accurately understood. That disorder of vision, to which I shall chiefly

* Communicated by the Author.

confine

confine my attention in the following paper, is a species of musca volitans apparently floating in the aqueous humour; which, excepting a slight notice by Mr. Ware (Medico-Chirurgical Transactions, vol. v.), has been wholly overlooked, or referred to other sources, by writers who have devoted themselves to this branch of medicine. Mr. Ware describes them as consisting of "a number of intersecting motes or beams, floating before the eyes. Sometimes they appeared nearly spherical, sometimes little long knotted lines, varying in number, size, and opacity." This description is most applicable when the observer looks towards a bright cloud, or gleam of sunshine through a window, immediately after waking in a morning. Where the light is more feeble they give the idea of dusky spots floating before the eye. Mr. Wardrop, in his work on the Morbid Anatomy of the Eye, speaking of floating muscæ, goes so far as to say, that "if they are produced by any spot or opacity in the transparent humours of the eye, it must be in the posterior part of the vitreous humour; because experiments, and the principles of optics, prove that no opacity of the aqueous, crystalline, or anterior part of the vitreous humour can throw a partial shadow on the retina." The opacities of the retina are those only which Mr. Wardrop has taken into consideration.

I have tried various means of illuminating the interior of the eye, in order to be enabled to examine these specks to the greatest advantage. They may be seen by looking through any small lens at a candle, but the optical reasons alluded to by Mr. Wardrop, render it advisable to use the smallest lens which can be procured; and the light thus entering by a very minute point, is obviously more likely to admit of a shadow being cast upon the retina by a small object between it and that membrane. By looking through a small hole in a plate of tin, I have also clearly seen a stratum of still smaller particles than those which appear as specks, and interfere (in a trifling degree) with vision, under ordinary circumstances.

Examining them by the above methods, these muscæ are found not to be opaque spots, but pellucid globules, and, as nearly as I can judge of their seat, floating in the aqueous humour. Though frequently suspended for a short time, they seem to possess greater gravity than the medium in which they exist, and when the eye is at rest sink below the line of vision. From this situation they can readily be projected upwards by a rapid motion of the globe of the eye in a vertical direction; and the best time for observing them is as they fall gradually to the lower part of the eye, passing across the field of vision. They are then seen distinctly to consist of globules, either detached,

detached, arranged in lines, or mingled irregularly together. The insulated specks exhibit a bright spot in the centre, (I have sometimes however seen it dark,) surrounded by a dark circle. They are, in fact, small lenses capable of converging the rays which fall upon them to a minute focal point; and the dark ring surrounding the central point is the shadow of the circumference of the globule, from which the rays of light have been directed to pass through the centre. In a very bright light, no less than four dark circles may be seen, the outer narrower and better defined than the inner ones. In the lines or strings of globules, the dark shadow is also seen, but under a different form, a double line of shade passing along each side of the chain; these lines appear to be indented at intervals, but not very clearly, as if the globules had been compressed by adhering to each other. On the slightest movement of the eye-ball they change their position, and are frequently lost sight of, but without any uniformity of direction or motion. The lines and groups, as well as the insulated globules, are perfectly unconnected one with another.

A close inspection in a good light discovers the minuter globules in great abundance; their density is so trifling as merely to give a spotted or mottled appearance to the fluid; they move altogether as if they formed a connected stratum, and in my own case are interspersed with a few larger and brighter points which keep their relative position. They will not sink much below the centre of the eye, though they may be projected above it; their descent is much slower than the motes described above. But that they really do descend may be proved by fixing the eye steadily, when they pass slowly downwards across the centre of vision, most clearly;—a sufficient proof that they are not diseased points of the retina. It may perhaps be said that they are merely the appearances which are produced by the mucus and tears spreading over the cornea, brought into view by the mode of examination mentioned above; but their characters and position are not altered by winking, which must happen if their source is external. In fact, the minute divisions of mucus are sometimes seen; and, besides the circumstance of their instant removal by winking, they differ so much from the internal globules as to be immediately distinguished from them.

What part of the eye, then, can be considered as the seat of muscæ, possessed of the characters ascribed to these, particularly their great and irregular mobility,—if not the aqueous humour?

XXX. *On*

XXX. *On* Mr. Witchell's *Method of clearing a Lunar Distance. By* C. Rumker, *Esq.**

I HAVE remarked that a very imperfect approximate foreign method for clearing the lunar distance (under some circumstances liable to considerable errors) is now much in vogue amongst British mariners, although they have better methods of their own: amongst which Witchell's appears to me one of the best. I think approximate methods better calculated for mariners than direct ones, since small errors are more likely to vitiate the result and more easily escape discovery than in the former, where the computer after a little practice can nearly judge from the altitudes and distance what each correction will amount to: and Witchell's enables him morever to assign to himself by a rough sketch the reasons for his proceedings. But as analytical demonstrations are now more approved, I offer you the following one of his formula, preceded by a simpler practical rule than the one usually given.

Add together the logarithms of,

Cotangent of half the sum of both apparent altitudes.
Tangent of half their difference.
Cotangent of half the apparent distance.

The sum of these logarithms is the tangent of an arc A, which must be added to half the apparent distance, and also subtracted from it. Then add together the logarithms of,

Cotangent of the sum of A and half distance.
Cotangent of the *lesser* apparent altitude.
Proportional logarithm of the corresponding correction.

Cotangent of the difference of A and half distance.
Cotangent of the *greater* apparent altitude.
Proportional logarithm of the corresponding correction.

The sums are the proportional logarithms of two corrections in distance, whereof the difference must be subtracted† from the apparent distance as long as A is less than half the apparent distance; but if A is greater, their sum must be added to the apparent distance if the moon's altitude is greatest, but subtracted therefrom if that altitude is least. With this corrected distance find from Table XXXV. of Norie's *Req. Tables*, the corrections answering to the moon's correction in altitude and in distance: their difference added to the corrected distance

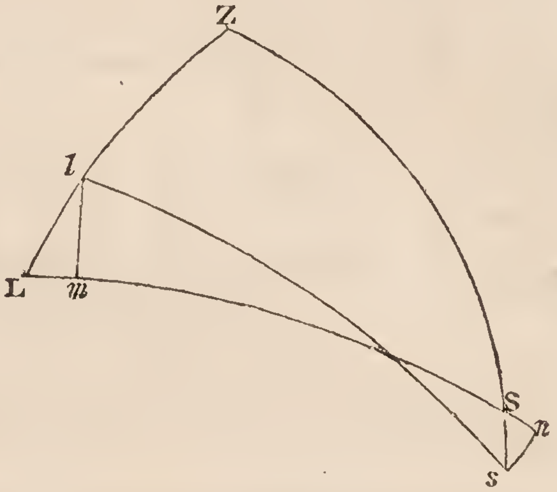
* Communicated by the Author.

† I here suppose that the correction in distance depending on the moon's altitude is greater than that from the sun. In the very rare contrary case their difference must be added when A is less than half distance.

if

if this is less, but subtracted from it if it is greater, than 90°, gives the true distance.

Demonstration.



$D =$ apparent distance L S.
$h =$ apparent sun's altitude.
$H =$ apparent moon's altitude.

Then is, with the omission of the third correction, which we shall explain hereafter, the true distance $ls = LS - Lm + Sm = LS - Ll \cos L + Ss \cos S$.

But $\cos L = \dfrac{\sin h - \sin H \cos D}{\cos H \sin D} = \dfrac{\sin h}{\cos H\; 2 \sin \frac{1}{2} D \cos \frac{1}{2} D}$

$$- \frac{\sin H}{\cos H \operatorname{tang} D} = \frac{\sin h \sec^2 \frac{1}{2} D - \sin H\,(1 - \operatorname{tang}^2 \frac{1}{2} D)}{2 \cos H \operatorname{tang} \frac{1}{2} D} =$$

$$\frac{\sin h - \sin H + (\sin h + \sin H) \operatorname{tang}^2 \frac{1}{2} D}{2 \cos H \,.\, \operatorname{tang} \frac{1}{2} D} =$$

$$\frac{\dfrac{\sin h - \sin H}{\sin h + \sin H} + \operatorname{tang}^2 \frac{1}{2} D}{\dfrac{\operatorname{cotang} H \,.\, 2 \sin H \operatorname{tang} \frac{1}{2} D}{\sin h + \sin H}} = \frac{\operatorname{tang} H \left(\dfrac{\sin h - \sin H}{\sin h + \sin H} \operatorname{cotang} \frac{1}{2} D + \operatorname{tang} \frac{1}{2} D\right)}{\dfrac{\sin h + \sin H - (\sin h - \sin H)}{\sin h + \sin H}}$$

$$= \frac{\operatorname{tang} H \left(\operatorname{tang} \frac{1}{2} D + \dfrac{\sin h - \sin H}{\sin h + \sin H} \,.\, \operatorname{cotang} \frac{1}{2} D\right)}{1 - \dfrac{\sin h - \sin H}{\sin h + \sin H} \operatorname{cotang} \frac{1}{2} D \,.\, \operatorname{tang} \frac{1}{2} D}$$

$$= \frac{\operatorname{tang} H \left(\operatorname{tang} \frac{1}{2} D + \dfrac{\operatorname{tang} \frac{1}{2}(h - H)}{\operatorname{tang} \frac{1}{2}(h + H)} \,.\, \operatorname{cotang} \frac{1}{2} D\right)}{1 - \operatorname{tang} \frac{1}{2} D \dfrac{\operatorname{tang} h\,(\frac{1}{2} - H) \operatorname{cotang} \frac{1}{2} D}{\operatorname{tang} \frac{1}{2}(h + H)}}.$$

and making $\operatorname{tang} A = \operatorname{cotang} \frac{1}{2} D \dfrac{\operatorname{tang} \frac{1}{2}(h - H)}{\operatorname{tang} \frac{1}{2}(h + H)}$

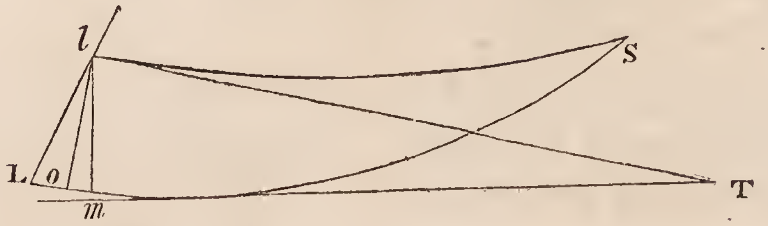
we have $\cos L = \operatorname{tang} H \,.\, \operatorname{tang}(\frac{1}{2} D \pm A)$ accordingly as $h \gtrless H$.

and also $\cos S = \operatorname{tang} h \operatorname{tang}(\frac{1}{2} D \mp A)$. Q. E. D.

In case that $A > \frac{1}{2} D$, the sign of the cosine of either L or S, and consequently that of the corresponding correction, will be changed. It may easily be proved that A is the part of the apparent distance intercepted between its middle and a perpendicular from the zenith upon it. It remains now to explain the third correction, which is nearly applicable to all approximate methods:

We have hitherto supposed $sl = sm$, which is incorrect. Describe

Describe from s as pole the circle $l\,o$, then is $o\,m$ the third cor-



rection. Draw at m a tangent and make $T\,l =$ tang D, then is

$$\sin T = \sin l\,m \,.\, \text{cotang } D.$$

but $m\,o \,.\, \sin 1'' = \text{tang } D\,(1-\cos T) = \text{tang } D \,.\, 2 \sin^2 \tfrac{1}{2} T$
$\tfrac{1}{2}$ tang D 4 $\sin^2 \tfrac{1}{2} T = \tfrac{1}{2}$ tang D $(2 \sin \tfrac{1}{2} T)^2 = \tfrac{1}{2}$ tang D $\sin^2 T$

$$= \tfrac{1}{2} \text{tang } D \text{ cotang}^2 D \sin^2 lm = \frac{\sin^2 L\,l - \sin^2 L\,m}{2 \text{ tang } D}.$$

Hamburgh, Jan. 16, 1831. C. Rumker.

XXXI. *Facts bearing on the Theory of the Formation of Springs, and their Intensity at various Periods of the Year. By* W. J. Henwood.

THAT those springs which exist during the winter and disappear as summer approaches, owe their origin to rain, has not I believe been disputed. But whether we may ascribe to the same cause those on which changes of the seasons appear to exert but little influence, has been frequently discussed. In the mining districts of Cornwall, registers of the performance of the steam-engines employed for pumping water, is periodically published by Messrs. John and Thomas Lean, of Camborne. These documents supply information from which it is not difficult to calculate the quantity of water drawn by each engine in a month, and consequently the intensity of springs at the spot. The particulars contained in the following columns are of some consequence in this investigation.

In some of the extensive mines several steam-engines are required; and as they are usually erected at a considerable distance from one another, each drains the whole of a certain district. Hence I think we may safely assume the water drawn by one engine as representing the intensity of the springs at that spot. The numbers in Table I. denote cubic feet of water drawn by one engine; in Table II. the averages of the respective mines are for one engine on each; but in Table III. the numbers are intended for cubic feet of water drawn by all the engines on each of the respective mines.

Mine

Mine.	Strata and Form of Surface.	Surface above Sea-level.*	Bottom below Sea-level.	Distance from Sea.	Situation.
		Fathoms.	Fathoms.	Miles.	
a †Poldice	Slate, at the foot of a hill which rises about 16°	28	140	4	1 mile E. of St. Day.
... ...	... ... near the summit of the hill	40	114		
... ...	Granite at the bottom. Slate upward....	40	134		
b Huel Harmony	Slate, a plain at foot of a granite hill	62	46	3·5	1 mile N. of Redruth.
c Huel Montague	Slate	60	52		
d Huel Rose......	Slate, between two small hills which rise about 8°	35 ?	95	2·75	6 miles N. of Truro.
e Poladras Downs	Slate, at foot of a granite hill which rises about 12°	46	59	5·	5 miles N.W. of Helston.
f Huel Hope ...	Slate, between two small hills which rise about 10°	50 ?	110	3·	4 miles W. of Camborne.
g United Mines	Slate, summit of a small hill	48	160 ‡	3·25	1·25 mile S.E. of St. Day.
h Huel Towan...	Slate, near summit of a hill which rises from the sea 10°	45	106	0·125	4 miles N.E. of Redruth.
i Great St. George	Slate	45	60	0·25	7 miles N. of Truro.
k Crinnis.... ...	Slate, an acclivity of about 8°	24	98	0·75?	2 miles E. of St. Austle.
l	... ...	14	58		
m Huel Falmouth	Slate, summit of a small hill	55	18	2·5	3 miles W. of Truro.
n Huel Maid. ...	Slate, an acclivity of about 15°	38	132 §	3·75	1 mile E. of St. Day.
o Ting Tang...	Slate, granite on the west at forty fathoms, a plain with a slight ascent;	54	120	4·	1 mile S. of St. Day.
	at foot of a granite hill	50	89		
p Consols	Slate, summit and side of a hill rising about 14°	39	131	2·75	2 miles S.E. of St. Day.
... ...	... ...	23	171		1·5 mile.
... ...	... ...	29	151		
... ...	... ...	49	151	3·25	1·25 mile.
... ...	... ...	52	131	3·75	1 mile.
... ...	... ...	52	166		
q Huel Unity.....	Slate, between two small hills rising about 8°	37	53 ‖	4·5	0·5 mile N.E. of St. Day.
... ...	Slate, granite at 87 fathoms, acclivity about 8°	45	121 ¶	4·25	0·25 mile.
r Dolcoath........	Slate, granite at 210 fathoms, plain at foot of a granite hill	62	188	4·	Camborne.
s Huel Damsel...	Granite, at foot of a hill rising about 17°...	59	143	4·	1 mile S. of St. Day.
... ...	... ... plain	42	112		
t Huel Reeth....	Granite, an acclivity of 12° at foot of a granite hill	66 ?	128	3·	3 miles W. of Hayle.
u Huel Gorland	Granite, summit of a hill	66	97	4·375	St. Day.
w Great Work ...	Granite, between two hills rising about 15°...	66 ?	60	4·	4 mile N.E. of Marazion.

* Many of the numbers in this column are from Thomas's Survey, p. 72–73.
† The letters will be found at the head of the columns to which they respectively refer, in Tables II. and III.
‡ 120 fathoms of the bottom have for some years been filled with water.
§ 24 fathoms of the lower part full of water.
‖ 40 fathoms of the bottom full of water.
¶ 30 fathoms of the bottom are filled with water.

It appears to me desirable to determine the intensity of springs at various depths, beneath the same surface; and this will be seen in the following columns, which denote the quantities drawn out of Huel Hope Mine, on which there is but one engine.

TABLE I.

	Depth of Mine in Fathoms.	1825. Cubic Feet of Water drawn out.	Depth of Mine in Fathoms.	1826. Cubic Feet of Water drawn out.	Depth of Mine in Fathoms.	1827. Cubic Feet of Water drawn out.	Depth of Mine in Fathoms.	1828. Cubic Feet of Water drawn out.	Depth of Mine in Fathoms.	1829. Cubic Feet of Water drawn out.
Jan...	...	......	74	2,428,149	77	2,699,121	88	*	112	2,889,535
Feb...	...	......	71	2,123,209	...	2,536,137	108	3,292,749	...	2,748,953
Mar...	...	......	...	2,562,010	...	3,362,051	...	3,125,796	...	2,788,771
April.	...	......	...	2,309,617	...	3,073,158	...	2,872,231	...	2,659,448
May .	...	......	77	2,092,514	...	2,873,097	...	2,874,119	...	2,788,974
June..	48	1,679,843	...	*	...	2,899,681	112	2,629,117	...	2,716,185
July...	53	1,482,723	...	1,766,160	...	2,833,634	...	2,662,792	128	2,285,164
Aug..	55	1,459,652	...	1,677,752	...	2,553,753	...	2,501,831	...	2,231,667
Sept..	56	1,335,605	...	1,584,818	...	2,273,581	...	2,264,919	...	2,242,170
Oct...	...	1,369,297	...	1,669,365	...	2,225,924	...	2,281,205	...	2,621,985
Nov...	...	1,346,398	...	*	...	2.309,194	...	2,146,405	...	2,489,828
Dec..	66	2,066,255	...	2,414,911	88	2,984,186	...	2,388,438	...	*

I by no means intend to imply that the increase observable in the preceding is entirely due to the augmented depth; for the horizontal excavations are continued at the same time, and I think a more extended series of observations requisite for determining what part of the increase should be assigned to each. The water is seldom drawn directly to the surface, but passes off through a gallery ("the adit"), which is excavated ("driven") from the nearest deep vale to the engine shaft, and is thence extended to the veins, which are usually much worked at this depth. The adit is in some mines forty-five fathoms from the surface; and by its great extension intercepts in its descent a large portion of the rain-water which has been absorbed by the earth. Of this quantity I have taken no notice. On the other hand there is a loss of water in the pumps, through imperfection of buckets and other apparatus; through the engine not making at all times its stroke of the full calculated length, and by its being sometimes worked more rapidly than the flow of water will supply ("going in fork"), and consequently drawing air.

Respecting the sum of all these defects practical men are by no means agreed; the extremes may be taken at one-fifth and one-tenth of the whole. In an experiment at Huel Towan†, in which I had the honour to assist Mr. Rennie, the observed quantity was to the calculated as 83 : 92, or thereabout. I think we shall not be very far wrong if we consider the rain-

† Phil. Mag. and Annals, N.S. vol. vii. p. 424.

rain-water carried off by the adit, counterbalanced by the deficiency of the engine's actual performance, when compared with its calculated duty. In which case the preceding numbers would nearly represent the intensities at that spot, provided we could apply a correction for the increase due to the horizontal increase in the extent of the mine. But the whole of this water is not drawn from the bottom, for in most of the galleries ("levels") there is some which is conveyed to the engine without being permitted to descend; yet as the veins are usually very porous, the greater part (say four-fifths) comes to the bottom, and the larger portion of the remainder from but little above; this obtains, however the depth may be augmented. The columns in Table II. are independent of one another; the lowest number in each being unity, they exhibit the monthly intensity of the springs in the various mines, on a mean of seven years; the column "ratio" denotes the relation of the average number of strokes per minute made by all the engines in Cornwall, and "rain," the ratio of rain; both for the same period. I purposely select mines in various parts of the county, the most distant being about thirty-three miles apart.

Perhaps it may be expected that I should offer some explanation of the differences in the following columns; but were I to attempt it, it must after all be very hypothetical. I therefore decline affording any.

It may not be out of place to observe, that when the United Mines were worked to a depth of 208 fathoms, the mean monthly quantity of water drawn out was about 13,000,000 cubic feet; at present they are worked to 90 fathoms depth, and the mean may now be about 4,350,000 cubic feet.

The area of the portion of Gwenap parish, which would be included by a line drawn in an east-north-east direction from Pennance to Huel Friendship, thence west-north-west to Huel Derrick, and from there south to Pennance, is about 1969 acres. Within this line are all the mines mentioned in Table III., there being steam-engines worked on them; beside others on which there are no engines, they being drained by the adjacent mines. Within the bounding line there are not more than three or four wells, but along the south and west lines there are several at a little distance; whilst about a quarter of a mile north of the north line is the stopped mine of Huel Busy, in which the water is at the adit. This affords a tolerably favourable opportunity for comparing the quantity of rain, falling on a known area, with the evaporation, and the quantity of water afforded by springs in a given time, from the same spot. The following columns, Table III., contain such a comparison; the evaporation being estimated from the register of W. Snow Harris, Esq. of Plymouth, who kindly permits me to use his numbers; and the rain from the register, published by E. C. Giddy, Esq. of Penzance, in this Journal.

I believe I correctly follow Mr. Daniell * in estimating the evaporation "from water, vegetation, or ploughed land" as equal; although this does not coincide with Mr. Dalton's observations on the same subject †.

It has been already remarked, that the computed quantity exceeds that actually delivered; and if we consider the difference to be one-seventh of the whole, there will still be an excess of 104,407,394·15 cubic feet ‡; nor will our conclusions be much falsified, by omitting the quantity afforded by wells, which probably does not much exceed 10,000 cubic feet per month. Whence then this excess?

Mr. Fox (whose kindness to me in innumerable instances has exceeded that of a parent) has in several cases detected muriate of soda in water from some of the mines situated several miles from the sea, and thence remarks: "It may be inferred from such facts as these, that the sea-water must in some places penetrate into the fissures of the earth, and consequently may in a greater or less degree assist in supplying the loss of moisture carried off by evaporation §," &c. The slate strata of Cornwall are usually considerably inclined, and the veins by which they are traversed being unconformable to the stratification, they must receive much of the water which percolates through the strata.

* Meteorolog. Essays, p. 122. † Manchester Memoirs, O.S. v. p. 361, 670.

‡ Mr. Dalton's experiments on the evaporation from mould and vegetative surfaces, to which I have already referred, are the only ones on these points which I have seen described in detail. If we follow the numbers there given by this illustrious philosopher, it will give a different value to the 8th and 10th columns of Table III. thus:

	Evaporation from a Surface of Water being for each Month unity, that from a Surface of Vegetation will be	The Evaporation on 1969 Acres, therefore	Differences between Water drawn and Evapor., and Rain.
		cubic feet.	*cubic feet.*
Dec.	·9893	4848712·69	— 9045621·78
Jan.	·672	3293576·19	+ 15012644·77
Feb.	·264	1335643·8	+ 10146946·25
Mar.	·178	1246293·71	+ 24972680·8
April	·33	3018614·62	— 3861611·79
May	·5412	8336444·65	+ 39824522·25
June	·3366	4789535·2	+ 4823217·9
July	·7276	7641600·89	— 1198998·76
Aug.	·5589	7826444·45	— 1903063·6
Sept.	·7577	9241229·49	— 10528726·26
Oct.	1·1365	9946719·14	+ 19607897·3
Nov.	1·0063	7500325·66	+ 26487825·57
		69,025,140·49	+114,337,712·65

cubic feet of water drawn, and evaporated more than the rain fallen; and when corrected for imperfection of apparatus, the excess still amounts to 59,881,580·54 cubic feet. The author has mentioned some of the objections to which his experiments are open. I shall therefore only remark that they seem to need repetition.

§ Cornwall Geol. Trans. iii. p. 324.

TABLE II.

	Poldice. *a*	Huel Harmony. *b* 1st Ser.	Huel Harmony. *b* 2nd Ser.	Huel Montague. *c*	Huel Rose. *d*	Poladras Downs. *e*	Huel Hope. *f*	United Mines. *g* 1st Ser.	United Mines. *g* 2nd Ser.	Huel Towan. *h*	Great St. George. *i*	Crinnis. *k* 1st Ser.	Crinnis. *l* 2nd Ser.	Huel Falmouth. *m*	Dolcoath. *r*	Huel Damsel. *s*	Huel Reeth. *t*	Ratio.	Rain.
Jan.	1·32	1·02	1·62	1·16	1·48	1·36	1·37	1·	1·41	1·29	1·12	1·54	2·03	2·62	1·33	1·32	2·05	1·23	1·81
Feb.	1·31	1·35	1·47	1·	1·28	1·2	1·37	1·23	1·63	1·09	1·01	1·46	1·83	2·26	1·23	1·14	1·85	1·26	1·52
Mar.	1·43	1·36	1·77	1·02	1·5	1·16	1·53	1·33	1·75	1·17	1·09	1·76	1·95	1·6	1·27	1·34	1·99	1·32	1·41
April	1·24	1·2	1·68	1·01	1·39	1·29	1·4	1·34	1·46	1·17	1·11	1·5	1·61	1·38	1·23	1·23	1·38	1·23	1·19
May	1·28	1·42	1·29	1·03	1·47	1·29	1·36	1·48	1·64	1·24	1·07	1·31	1·89	1·72	1·24	1·28	1·29	1·17	1·19
June	1·17	1·09	1·22	1·05	1·2	1·37	1·27	1·12	1·31	1·16	1·12	1·2	1·57	1·86	1·17	1·28	1·12	1·11	1·
July	1·16	1·16	1·18	1·	1·12	1·16	1·13	1·04	1·32	1·09	1·2	1·2	1·59	1·44	1·04	1·11	1·04	1·07	1·14
Aug.	1·07	1·16	1·16	1·07	1·	1.18	1·07	1·38	1·16	1·04	1.19	1·12	1·56	1·	1·	1·09	1·	1·02	1·58
Sept.	1·	1·06	1·04	1·01	1·01	1·18	1·	1·16	1·03	1·	1·12	1·	1·53	1·03	1·	1·04	1·07	1·01	1·55
Oct.	1·08	1·04	1·2	1·1	1·03	1·24	1·04	1·25	1·03	1·06	1·13	1·1	1·78	1·79	1·02	1·02	1·23	1·	1·95
Nov.	1·04	1·17	1·	1·08	1·1	1·	1·06	1·34	1·05	1·01	1·04	1·2	1·	3·27	1·01	1·	1·42	1·03	1·66
Dec.	1·18	1·	1·52	1·24	1·49	1·	1·26	1·37	1·	1·13	1·	1·59	1·65		1·25	1·19	2·3	1·17	2·19

TABLE

TABLE III.

	United Mines. g cubic feet.	Consols. p cubic feet.	Ting Tang. o cubic feet.	Poldice. a cubic feet.	Huel Unity*. qu cubic feet.	Huel Damsel. g cubic feet.	Total Quantity of Water drawn out of the Mines. cubic feet.	Evaporation. cubic feet.	Total Quantity of Rain fallen. cubic feet.	Difference between Amount of Evaporation and Water drawn, and Rain fallen. cubic feet.†
1828. Dec.	4173845·58	12093580·69‡	2655401·21‡	5779876·36‡	4537336·89‡	1358625·53	30598666·28	4901155·05	44493000·75	− 8993179·42
1829. Jan.	4745878·97	13088543·09	2894792·25‡	6389641·04‡	5459162·6 ‡	1512631·72	34090649·68	4901155·05	22371581·1	+ 16620223·63
Feb.	4198094·75‡	11747636·98	2286188·89	5918852·9 ‡	4673173·76	1465502·51‡	30289449·8	5059256·83	21478147·35	+ 13870559·28
Mar.	5071161·97	13190497·02	2468925·09‡	6747528·66‡	5105922·77	1613395·1	34197430·64	7001650·08	10471043·55	+ 30728037·17
April	4579744·8	13108963·54	2585917·71	6088332·14‡	4641488·76	1426411·62	32430858·59	9147317·04	39311085·	+ 2267090·63
May	5328338·85	14537395·22‡	2530721·87	6479687·74‡	5056318·37‡	1558198·74	35490660·8	15403630·17	4002583·2	+ 46891707·77
June	4327238·2	13274758·99‡	2397175·23	5699157·68‡	4985978·89‡	1370039·29	32054348·3	14229159·84	32020665·6	+ 14262842·54
July	4067023·2	12694379·66‡	2522465·85	5912266·95‡	4910772·29	1185536·44	31292444·4	10502475·12	40133044·05	+ 1661875·47
Aug.	3732569·96	12448347·63	2470127·61	5394198·32‡	4442697·92	1200847·54	29688789·	14003300·16	39418297·05	+ 4273792·11
Sept.	3811897·04	11916143·56	2288730·67	5530541·7 ‡	4243524·71	1184951·96	28975789·65	12196422·72	48745745·4	− 7573533·03
Oct.	4295971·92	12338948·52	2606918·23	5981173·71‡	4858766·49	1256970·73	31338749·61	8752062·6	21677571·45	+ 18413240·76
Nov.	4344319·09	12171499·54	2706679·36	5739619·07‡	4548799·96	1234171·01	30745088·06	7453369·44	11757588·15	+ 26440869·35
							381192924·81	113550954·1	335880352·65	+158863526·26
							$\underbrace{\hspace{6em}}_{492,743,878\cdot 91}$			

* So much of this as a 4·5-inch pump draws, is from Huel Gorland.

† In the column of "Differences" when the sum of the "Water drawn," and "Evaporation," exceeds the "Rain," I prefix the sign +; and when the contrary the sign —.

‡ All the engines on the mines, for the months thus distinguished, (‡) are not reported: their performance I approximate from its duty in the preceding month, and from that of the others for the present.

But as the metalliferous veins, which have a direction of from east to west, or thereabouts, suffer frequent intersections and dislocations by the cross veins, they do not convey the liquid to a very great distance in their longitudinal extent. But the cross veins, which have a direction of about north and south, are in many cases supposed to traverse the Cornish peninsula from sea to sea, and although sometimes, are not frequently, dislocated, and consequently may be the medium through which sea-water may enter the mines. There are some mines in which the water stands at the adit, (North Downs and Huel Busy,) which intervene between those in which the muriate of soda was detected and the sea; but as the latter are by far the déeper, it may be readily admitted that the percolation may have taken place at or near the lowest levels. But it has not yet been shown that sea-salt does not exist in the water of North Downs and Huel Busy; and until a long continued series of observations shall show its absence, I think we may reasonably adopt Mr. Fox's suggestion.

The level at which the water stands in some stopped mines is not unworthy of notice. Poladras Downs is about a mile north of Huel Vor; before its working was resumed, the water during the winter stood at the adit, but in summer it sunk below that level, which is fourteen fathoms deep. Great Work and Huel Breage are about a mile west of Poladras; in winter the water runs out at the adit, but in summer it sinks three or four fathoms; the adit is about thirty fathoms deep. These facts have been communicated to me by G. S. Borlase, Esq. F.R.S. In Huel Falmouth, before the resumption of operations, the water rose to the adit, twenty-five fathoms deep, in winter; whilst in summer it sank about six or seven feet beneath it.

I believe it may be assumed as a general fact, to which there are not many exceptions, that, *cæteris paribus*, mines worked in the slate of Cornwall afford much more water than those in granite.

I believe my numbers do not coincide with Mr. Dalton's on the same subject*; but through the kindness of John Taylor, Esq. F.R.S., I am to be favoured with engine-reports and other information from his mines in Mexico; and if leisure permit, I hope to submit them to calculation, as they may assist in determining the question on which I feel compelled to differ from such high authority.

W. J. H.

Perran Wharf, near Truro,
January 28th, 1831.

* Manchester Memoirs, O. S. v. p. 346.

XXXII. *On the Calculation of the Orbits of Double Stars.* *By* Professor ENCKE*.

IT was the immortal Herschel who, among his many grand views, first directed the attention of astronomers to the highly remarkable phænomenon that so many stars are placed closely together, and to the conclusion which he drew from this circumstance, that there is great probability that two such stars, separable only by highly magnifying telescopes, are not only apparently near each other, owing to the place whence they are viewed, but that they really form in space a coordinate system; that they act upon one another, and in consequence undergo changes in their relative positions, which, after longer or shorter intervals, may be capable of observation, and whose laws may be developed in the course of time; and from that moment a new field has been opened for practical astronomy, the extent of which it is not yet possible to determine. Herschel was not satisfied with merely advancing this hypothesis, but he, in the beginning of his career, thoroughly examined the heavens, and recorded a number of observations on the relative positions of stars thus placed closely together, in order to transmit to future times safe points of comparison; and he enjoyed the satisfaction of learning, that on a new examination, after a lapse of more than twenty years, such sensible changes were observed, in several double stars, as left no doubt regarding the truth of his hypothesis. After him, Struve of Dorpat first resumed these investigations, confirmed the observations of Herschel, and after a due appreciation of his wonderful zeal, and the eminent skill evinced by him in the management of inferior means, he obtained, in the great refractor of Frauenhofer, one of the most powerful instruments for accurately investigating this subject. Herschel (the son), and South, had in the mean time likewise devoted their eminent talents to the observation of double stars; and since the new catalogue of Struve has proved the vast number of such systems; since the comparison of the observations made with different instruments, and after different methods, promises a by far greater degree of accuracy than was formerly expected; since, lastly, practical optics, in England, France, and Germany have, with regard to the size of instruments and the distinctness of images, reached a perfection hitherto deemed unattainable, the observations of double stars have obtained much additional interest.

Our experience is, indeed, as yet too short to derive from it any thing permanently correct; the whole space of time to

* From Encke's Ephemeris, for 1832.

which

which it extends being hardly fifty years, during which time even the subject has neither been continually nor closely pursued, as it is at most fifteen years during which the attention of several astronomers has been simultaneously directed to it. As there are, however, a few systems of stars the observations of which embrace nearly a full revolution, and as in the case of others considerable portions of the curve in which they move may be determined, it cannot be deemed an idle speculation to apply to those distant systems the laws by which our solar system is governed, in order to perceive how far these laws may then be confirmed.

The only course we can adopt in this respect is to apply the Newtonian law of gravity, whose truth, within the limits of our solar system, may be considered as rigorously demonstrated, and whose extension beyond those limits possesses the highest degree of probability. Agreeably to that law the relative orbits of two celestial bodies, subject only to their present mutual action on one another, will be a conic section, or, in the case here under consideration, an ellipse.

The point in which most probably such systems of stars will differ from our solar system, viz. that the difference between the two mutually attracting masses will not in them be so considerable as in the case of the sun and planets, has no influence on the orbit; and instead of considering the motions of both bodies around their common centre of gravity, we may with perfect rigour suppose the one to be at rest, as it were, in the seat of the central force. If we denote the mass, and the three coordinates, referred to an arbitrarily assumed system of three rectangular axes, of the one star by m, x, y, z, those of the other by m', x', y', z', their distance by ϱ, and the time by t, the differential equations of the motion of the one star, as far as it is only acted upon by the attractive forces of the other, will be, agreeably to the Newtonian law of gravity,

$$\frac{d^2 x}{d t^2} + \frac{m'(x-x')}{\varrho^3} = 0, \quad \frac{d^2 y}{d t^2} + \frac{m'(y-y')}{\varrho^3} = 0,$$

$$\frac{d^2 z}{d t^2} + \frac{m'(z-z')}{\varrho^3} = 0, \quad \text{and those of the other star:}$$

$$\frac{d^2 x'}{d t^2} + \frac{m(x'-x)}{\varrho^3} = 0, \quad \frac{d^2 y'}{d t^2} + \frac{m(y'-y)}{\varrho^3} = 0,$$

$$\frac{d^2 z'}{d t^2} + \frac{m(z'-z)}{\varrho^3} = 0.$$

and

and from their combination we obtain the following:

$$\frac{d^2(x'-x)}{dt^2} + \frac{(m'+m)}{\varrho^3}(x'-x) = 0,$$

$$\frac{d^2(y'-y)}{dt^2} + \frac{(m'+m)}{\varrho^3}(y'-y) = 0,$$

$$\frac{d^2(z'-z)}{dt^2} + \frac{(m'+m)}{\varrho^3}(z'-z) = 0,$$ which are the

differential equations of an elliptical motion, for which the central force $m'+m$ may be supposed to reside in the one star. The knowledge of the ratio of this mass to that of the sun will not be obtained until the parallax of this pair of stars is known; nor will the ratio of m and m' be ascertained until we have determined the law, according to which the centres of gravity of the different systems move about, and until by its application we can ascertain the position of that point between the two stars, for which it is true, or of their common centre of gravity*. Our observations do not refer to the ellipse actually described by the moving star about the one at rest, but to its projection on a plane vertical to the line of vision. The projection of a conic section on a plane any how inclined being likewise a conic section, the projection will in our case likewise be an ellipse, with this difference only, that the star at rest will no longer be in its focus. The determination of the orbit of the double stars is, therefore, on the one hand incomparably more easy than the determination of the orbits of planets, inasmuch as the change of position of the observer does not come into consideration. But, on the other hand, it is more difficult, because the focus itself of the ellipse is not given, but only its projection in the projected ellipse, and the mass being unknown, the measure of areal velocity is wanting. As, therefore, in the case of planets, six data or elements are sufficient, because by them, combined with the known mass of the sun, or the k in Gauss's *Theoria Motûs*, &c. which depends on it, the areal velocity itself is given, so in the case of double stars this latter must be separately ascertained, and we want, consequently, the determination of seven elements.

Every observation gives, besides the moment of time, two coordinates in the plane of the projected ellipse, which determine the relative position of the moveable stars with regard to the one at rest. Three complete observations or the six quantities obtained by them, and independent of one another,

* See Bessel, in Zach's Monthly Corresp. 1812, August, p. 161.

are

are not sufficient for the determination of seven elements. Four observations are still more than sufficient. In a similar manner however, to the determination of the orbit of a comet, the superfluous datum of the four observations may be made use of for obtaining, in conjunction with another, a datum which is more suitable to the calculation, or it may be employed for any other particular purpose, and for facilitating the development. If the time were not to be taken into consideration at all, it would be necessary, the ellipse having five constants in its most general equation, to have five distances, with their intermediate angles, in order to obtain the projected ellipse. The condition that the point from which the distances have been taken, is the projection of the focus of the true ellipse, would give the position of the plane, and consequently its true form. If, however, the observations were in other respects incomplete; if, for instance, at a given time only one of the polar coordinates, perhaps only the angle of position, as it is called, had been observed, and as it will be by no means advisable to neglect an element, which is so easily obtained as the time, we should require as many observations as there are elements to be determined; viz. seven.

The latter case may perhaps arise in future, as, according to our present experience, it is more easy to determine the angle of position with a certain degree of accuracy, than the distance. For the present time, however, it would be superfluous to found the determination of an orbit on such incomplete observations, which presents, as it appears, greater difficulties than that founded on the employment of complete observations. The epochs are as yet not distant enough from one another to allow the selection of seven of them. I limit my investigations, therefore, to the case of four complete observations, from which the orbit of a double star is to be derived.

M. Savary has already treated the same subject in the *Conn. des Temps* for 1830, and has illustrated his methods by an application to ξ Urs. Maj. in such a manner as to present in his calculations a closer conformity to the observations, than could have been expected from the difficulty of obtaining them. The difference of his deduction from that which here follows, consists perhaps only in his employing the properties of the ellipse when referred to its conjugate diameter; while my investigations are founded on the relations usually employed in astronomy. My formulæ may also, perhaps, be more convenient for calculation.

Let the star which is considered to be at rest be the point of beginning of the coordinates, and let the times of the observations in their proper order be t_1, t_2, t_3, t_4.

The

The observations commonly give immediately the polar coordinates of the moveable star, when the angles are reckoned, sometimes from the circle of declination, sometimes from the parallel of the star at rest. Let the angles reckoned from any one of the principal axes, in the direction of the motion, from 0° to 360°, be designated by p_1, p_2, p_3, p_4; and let the distances be expressed by $\varrho_1, \varrho_2, \varrho_3, \varrho_4$. In comparing linear dimensions it is more convenient to have rectangular coordinates. If we consider, therefore, the principal axis as the axis of one of the coordinates, and an axis perpendicular to it as that of the others, we have, with due regard to the signs of the trigonometrical functions,

$$\xi_1 = \rho_1 \cos p_1, \ \xi_2 = \rho_2 \cos p_2, \ \xi_3 = \rho_3 \cos p_3, \ \xi_4 = \rho_4 \cos p_4$$
$$\eta_1 = \rho_1 \sin p_1, \ \eta_2 = \rho_2 \sin p_2, \ \eta_3 = \rho_3 \sin p_3, \ \eta_4 = \rho_4 \sin p_4$$

If we designate the origin of the coordinates by 0, and the respective places of the star by 1, 2, 3, 4, and the double areas of the triangles inclosed by any three of these five points, by the respective three numbers in parentheses, we have the following six expressions:

$$\text{(A)} \quad \begin{aligned}
(0\,1\,2) &= \varrho_1 \varrho_2 \sin (p_2 - p_1) = \eta_2 \xi_1 - \eta_1 \xi_2 \\
(0\,1\,3) &= \varrho_1 \varrho_3 \sin (p_3 - p_1) = \eta_3 \xi_1 - \eta_1 \xi_3 \\
(0\,1\,4) &= \varrho_1 \varrho_4 \sin (p_4 - p_1) = \eta_4 \xi_1 - \eta_1 \xi_4 \\
(0\,2\,3) &= \varrho_2 \varrho_3 \sin (p_3 - p_2) = \eta_3 \xi_2 - \eta_2 \xi_3 \\
(0\,2\,4) &= \varrho_2 \varrho_4 \sin (p_4 - p_2) = \eta_4 \xi_2 - \eta_2 \xi_4 \\
(0\,3\,4) &= \varrho_3 \varrho_4 \sin (p_4 - p_3) = \eta_4 \xi_3 - \eta_3 \xi_4
\end{aligned}$$

From their combination the triangles between the places themselves may be derived. We have

$$\text{(B)} \quad \begin{aligned}
(1\,2\,3) &= (0\,1\,2) + (0\,2\,3) - (0\,1\,3) \\
(1\,2\,4) &= (0\,1\,2) + (0\,2\,4) - (0\,1\,4) \\
(1\,3\,4) &= (0\,1\,3) + (0\,3\,4) - (0\,1\,4) \\
(2\,3\,4) &= (0\,2\,3) + (0\,3\,4) - (0\,2\,4)
\end{aligned}$$

which, however, are connected together by the following equation of condition:

$$\text{(C)} \quad (1\,2\,3\,4) = (1\,2\,3) + (1\,3\,4) = (1\,2\,4) + (2\,3\,4).$$

Agreeably to the nature of the ellipse, the signs of the areas (B) must always be positive. A negative sign in the areas (A) denotes that if the triangle be conceived to be formed by the movement of the distance to which the greater index belongs, a movement through an angle of more than 180° in the positive direction has taken place.

If we denote, in a similar manner, the chords between any

any two of the four places by the respective two numbers in parentheses, we have

$$
(\mathrm{D}) \quad
\begin{aligned}
(1\,2)^2 &= (\xi_2 - \xi_1)^2 + (\eta_2 - \eta_1)^2 \\
(1\,3)^2 &= (\xi_3 - \xi_1)^2 + (\eta_3 - \eta_1)^2 \\
(1\,4)^2 &= (\xi_4 - \xi_1)^2 + (\eta_4 - \eta_1)^2 \\
(2\,3)^2 &= (\xi_3 - \xi_2)^2 + (\eta_3 - \eta_2)^2 \\
(2\,4)^2 &= (\xi_4 - \xi_2)^2 + (\eta_4 - \eta_2)^2 \\
(3\,4)^2 &= (\xi_4 - \xi_3)^2 + (\eta_4 - \eta_3)^2
\end{aligned}
$$

The equations (A) (B) (C) (D) contain the data of the observations.

[To be continued.]

XXXIII. *A Botanical Description of* Hermione Cypri. *By* A. H. Haworth, *F.L.S. &c. &c.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN my last communication to your useful Magazine, N. S. vol. viii. p. 130, it was stated, under the description of *Hermione tenuiflora*, that the double and semi-double flowering varieties, hitherto proposed doubtingly under it, were probably of another and distinct species, supposed to come from the Island of Cyprus, which I there designated *H. Cypri.*

At that time the flowers, in their single state, had not fallen under my examination. In fact I never could procure or find the plant in that state until the present time; when the acute eye of my friend Mr. Sweet detected a specimen of it, nearly in full bloom, amongst Mr. Colvill's forced bulbs, at his noble Nursery in the King's Road; whither I went to examine it, and there saw along with other bulbous plants, in full bloom, the most showy and best managed collection of Hybrid *Amaryllidæ* I ever beheld.

I had no sooner pronounced the *Hermione Cypri* new to me, and to be undescribed, by any modern writer at least, in its single state, than Mr. Colvill, with his usual kindness towards helping me to elucidate this beautiful tribe of plants, made me a present of it; although it was the only one in his extensive collection.

I am the more flattered at this, because it enables me to show that the conjecture I made, as above cited, concerning the distinctness of this species, has not proved incorrect. And I hope to persuade Mr. Sweet to give the botanical world a representation of it, from the pencil of his excellent artist Mr. Smith, in an early Number of his beautiful British Flower Garden.

Garden. I have carefully drawn up the following botanical description of *H. Cypri*, for your Magazine; and remain,

Gentlemen, yours, &c.

A. H. Haworth.

Genus, Hermione Nob. in *Narciss. Revis. p.* 121.

Sectio secunda Albæ.

Cypri. H. (slender early white) scapo subquadrifloro, gracili; corollæ laciniis obovatis, mucronatis, subimbricantibus, semireflexis; coronâ cupulari luteâ, truncatâ, sesquiduplò longioribus.

N. Cypri Nob. in *Phil. Mag. N.S.* viii. 133–4.

Habitat in Insula Cypri.

Floret in caldario in Januario, sed in aëre aperto forsan in Martio.

Descriptio. *Herba* tunicatim bulbosa, subpedalis. *Folia* erecta, lorata, hujus generis ordinaria, supernè primò ferè plana, obtusa, viridia, post florescentiam longiora, obliquè flexa. *Scapus* gracilior quàm in affinibus proximis, striatus, virens, ferè solidus; basi teretiusculus, supernè sensim parùm compressus et anceps; florendi tempore foliorum altitudine; demùm illis brevior, et supernè cavus. *Spatha* in exemplo nostro quadriflora, ordinaria, erecta, altitudine pedunculorum minorum. *Pedunculi* erecti, inæquales, 1–2-unciales, graciles, acutè triangulares, lætè virides, elevatìm striatuli, *germine* (florendi tempore) parvo, oblongo, obtusè triangulari, striatulo, saturatiore. *Flores* eleganter rectangulatìm nutantes, vel plùs; sed nunquam cernui: *corollæ, laciniis* obovatis vel oblongo-obovatis seu ferè ellipticis albis, extùs basi luteis (interioribus minoribus, ut in omnibus et minùs mucronulatis), *tubo* respectu primo ferè horizontalibus, planis, vel variè paululùm flexis et imbricantibus; demùm semireflexis, et variè flexuosim obliquis; *tubo* prismatico lætè viridi, gracili, parùm longioribus. *Corona* lutea, crassa, firma; ore integro, ruptatim subindè unifissa subregularis, et paulò latior quàm altior. *Stamina* ordinaria et *pollen* coronæ concolora, 3 interiora *tubo* humiliora; *antheris* ordinariis inclusis, tria alia *tubi* altitudine, *antheris* protuberantibus. *Stylus* gracilis, albicans, *coronam* æquans, *stigmatibus* tribus exiguis seu minimis, planis, patulis, subrotundis, albis.

Obs. N. Tazettæ *Linn.* in *Fl. Græc.* tab. 308, pulcherrimè representata, simillima, ut ovum ovo; at differt

differt *bulbo triplo majore; scapo* basi solidiusculo *non cavo; foliis* (in caldario) *non glaucescentibus;* planis, *non flexulis;* florum *pedunculis* acuto-triangularibus, *non teretiusculis, laciniis* corollæ valdè albis, *nec lacteis; tubo* parùm longioribus, nec *tubi longitudine; coronâ* luteâ, *nec aurantiâ,* sesquiduplò nec *triplò longioribus,* et lævi, *non plicata,* ut in *Fl. Græca* supra citatâ.

β. *semiplena.* Park. Parad. 85. *fig.* 2.

γ. *plena.* Park. Parad. 85. *f.* 3. 4.

I dare not cite the beautiful figure of *tab.* 1011, in the *Botanical Magazine,* there called *Narcissus orientalis, var. Fl. Pl.,* because that plant shows eight flowers on its slender scape, which in that respect very well agrees; but I much doubt whether ours would ever have more than four or five. But it may be the double state of *N. Tazetta* of *Fl. Gr. l. c.,* as the latter is there said to bear, when cultivated, *many* flowers.

If this conjecture proves correct, it will afford another instance of extremely similar species often occurring, as it were, in pairs; as in *H. præcox* of Tenore; and *H. tenuiflora* Nob. *H. papyratia,* Bot. Mag. 947, and *H. Jasminea* Salisb. et Nob. and many others.

That zealous and indefatigable Botanical Professor Dr. Schultes, assisted by his son Dr. Schultes, have greatly aided my endeavours to elucidate the *Narcisseæ,* by completely copying the whole of my last contribution to your excellent Magazine, on these much favoured plants, into the *Addenda* at the end of the 7th volume of their new edition of *Linn. Syst. Veg.* just published; which will doubtless spread the matter much more extensively than has hitherto been accomplished.

Chelsea, Feb. 7th, 1831.

XXXIV. *On an Omission in* Clairaut's *Theory of the Equilibrium of a homogeneous Fluid; in some Remarks on the 56th Article of the* "Bulletin des Sciences Mathematiques" *for August* 1830. *By* James Ivory, *Esq. M.A. F.R.S.**

An article in the *Bulletin des Sciences Mathematiques* for August 1830, demands some observations from me.

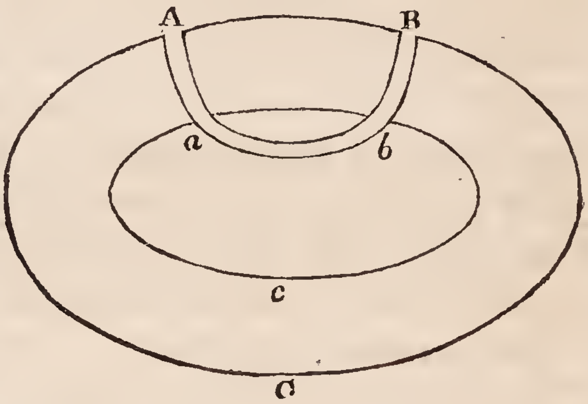
We may begin with stating, in what Clairaut's theory of the equilibrium of a homogeneous fluid consists. This is a point not in any respect doubtful. According to the inventor of the theory and all other authors, two conditions are necessary and sufficient for the equilibrium. Supposing the equilibrium possible, it gives only one equation for determining the figure of the fluid. No accelerating forces are taken into account

* Communicated by the Author.

account except those in action at the outer surface; and it is implied that the like forces, expressed by the same functions of the coordinates, and no others but these, act upon every interior particle of the mass. It follows from this view of the matter that the level surfaces depend entirely on the outer surface, and attempts are made to demonstrate this.—Vide *Méc. Cél.* livre iii. § 22.

On the other hand I contend that the figure of the fluid will depend upon the forces that actually urge every particle to move from its place: that, in a homogeneous planet in a fluid state, there are forces prevailing in the interior parts, which Clairaut has neglected: and that the equilibrium is impossible, unless such a figure of the fluid can be found as will set free the interior particles from those irregular forces. For this purpose the true figure of equilibrium must possess a property not deducible from Clairaut's theory; and this new condition, although it relates only to a particular problem, or to similar problems, it is usual to call my new principle of hydrostatics.

In the 27th volume of the *Annales de Chimie et de Physique*, p. 231, M. Poisson considers a homogeneous planet A B C, supposed fluid and in equilibrium. The interior surface *a b c* is similar and similarly posited to the outer surface A B C, on which supposition the interior mass *a b c* will be separately in equilibrium if the exterior stratum were taken away. The narrow canal A *a b* B has its ends in the upper surface A B C, and the part between *a* and *b* is wholly within the interior mass *a b c*. M. Poisson proves that the equilibrium of the whole canal requires this equation,



$$\delta = q - p, \text{ or } p = q - \delta;$$

p and q being the weights of the canals A a and Bb, and δ the effort of the fluid in the canal $a\,b$, acting from a to b and caused by the attraction of the matter between the two surfaces. Now I observe that M. Poisson, by allowing that the stratum attracts the particles within it, and by calculating the pressure δ produced by its action, admits the omission made by Clairaut, and in reality proves that the theory of that geometer is insufficient for solving the problem. For there is no force at the outer surface A B C, similar to the attraction of

of the stratum between the two surfaces upon the particles within the lower surface. Such an attraction therefore can have no place in the theory of Clairaut, which notices no forces except those in action at the outer surface. It is implied in the theory that the only forces urging a particle, whether situated in the surface or in the interior parts of the fluid, are the centrifugal force and the attraction of the whole mass; these forces produce the pressures of the canals a A and b B; but they have no connection with the pressure δ, which has quite a different origin. The theory of Clairaut is therefore insufficient for determining the equilibrium, because it leaves out some of the causes tending to change the figure of the fluid.

Further, I shall prove that the equation found by M. Poisson leads to two independent conditions for the figure of equilibrium. These conditions are, first, the equation of the outer surface, which is all that Clairaut's theory requires; secondly, the equality of pressure at all the points of every interior surface, as $a\,b\,c$, similar and similarly posited to the outer surface. For we may suppose that one end a of the canal $a\,b$ remains fixed, while the other end b is successively applied to every point of the surface $a\,b\,c$; in every position of the canal we shall still have the equation,

$$p = q - \delta;$$

from which it follows that $q - \delta$ is equal to the constant quantity of p at every point of the surface. Now, q being the weight of the canal b B, and δ the effort of the canal $a\,b$ towards b, caused by the attraction of the stratum, the intensity of pressure at every point of the surface $a\,b\,c$, will be the same. By means of this property, the equation of the surface $a\,b\,c$ will be derived from the equilibrium of the whole mass A B C; the same equation is deducible from the separate equilibrium of the interior mass $a\,b\,c$; and as the two equations must be identical, we thence obtain a condition which is independent of the outer surface of the fluid.

When the conditions for the equilibrium are more attentively investigated, it will appear that the attraction of the stratum upon the particles in the inside must produce no internal pressure. From this it follows that $\delta = 0$ in M. Poisson's equation. In a paper in the Phil. Trans. for 1824, in which I first considered this problem, I have fulfilled what is physically required for the equilibrium by supposing that the stratum attracts every particle in the inside with equal force in all opposite directions. I have since found that this is not exact in all laws of attraction. But the fluid within the stratum

will be freed from all pressure caused by the attraction of the exterior matter, if the stratum exert no attractive force upon the particles situated in its lower surface; and this property, more general than the other, is indispensably required for the equilibrium. The paper alluded to must therefore be corrected by substituting the second property in place of the first; for which purpose nothing more is necessary than a change of the language in some parts, without any alteration of the calculations or the results.

In a homogeneous fluid in equilibrium it may be proved that the whole matter above any level surface must act upon the fluid below it by external pressure only, without exerting any accelerating force upon the particles that may cause internal pressure: and, as this is general whatever be the nature of the accelerating forces, it may properly enough be called a new principle of hydrostatics.

The embarrassment attending the application of Clairaut's theory arises from that author having failed to lay down the *independent* conditions of the equilibrium. Of the two conditions which are asserted to be necessary and sufficient for the equilibrium, one is included in the other: for it is easy to prove that the equation of the outer surface is deducible from the other condition.

Feb. 12, 1831. JAMES IVORY.

XXXV. *An Examination of those Phænomena of Geology, which seem to bear most directly on theoretical Speculations. By the Rev.* W. D. CONYBEARE, *M.A. F.R.S. F.G.S. &c.*

[Continued from page 116.]

Part the Second.—*Of Aqueous Action, and the excavating Forces which have operated on the Strata.*

THE phænomena of geology (to assign an adequate cause for which, is the legitimate aim of theory) appear to me reducible to two classes:—1. those which indicate igneous action and the operation of elevating and dislocating forces on the strata; and, 2. those which indicate aqueous action and the operation of excavating forces. My former observations, which I would consider as constituting the first part of my present essay, have been dedicated to the first class of these phænomena; and I now propose to enter on the second. On these two heads, the difference between Mr. Lyell and myself amounts simply to this: Mr. Lyell believes that the forces which act on our planet have been, and are, ever constant and invariable; that therefore as to the first topic, all the

the dislocations of the strata and all the probable ignigenous products have resulted from volcanos acting precisely with the same energy and under the same circumstances as at present; and that it would not be in the least improbable that all these phænomena should be reproduced to-morrow. I, *e contra*, have endeavoured, by a tolerably detailed examination of those phænomena, to show, that the only fair inference from them is the direct contradictory of the above proposition; and that they universally indicate forces acting most violently in the earliest epochs, but gradually decreasing in intensity through the subsequent periods: so that the actual state of the planet is one of comparative repose,—the present convulsions which partially affect its surface being only, as a French writer has observed, the last faint struggles of the expiring giants.

Now as to the second head, of Aqueous Action, &c., we find in several geological positions, but most especially and most generally as a superficial covering indifferently investing every other formation, vast accumulations of gravel, evidently consisting of debris originally torn from the rocky strata of those formations, and subsequently rounded by attrition under water. We also find the strata themselves traversed by breaches and ploughed by deep furrows, so that the surface has been not unaptly compared to a block of stratified marble irregularly cut into by a graver's tool. Now, associating together these fragmented ruins and yawning breaches, it is as natural to refer them to the same cause, as if we should notice a breach in a wall regularly constructed of masonry, and observe its loosened and removed blocks piled beneath it;—but what is that cause? what is the graver's tool which has thus sculptured the face of our planet? Mr. Lyell says that the streamlets actually flowing through our valleys are adequate to account for all, if we will but throw all prejudice aside, and allow a sufficient number of millions (I should rather say *infinit-illions*) of ages since their continued action. This may be called the Fluvial theory; or more properly, the Atmospheric theory: for it evidently amounts to this, "that the atmospherical waters falling on any given district and draining off from it are adequate to produce, by their continued action, all the phænomena of water-worn gravel and excavation which we observe in that tract." Now it will be my endeavour to show, from the arrangement and investigation of those phænomena, that the atmospheric drainage, even if continued for ever *and a day* (that with the liberality of common parlance I may allow all the time I can), is altogether incapable of accounting for them; and

and that they indicate the effects not of drops and rills *, but of violent currents and of vastly extended sheets of water. This I shall call the Diluvial theory, premising that I use the term diluvial only in a general and philosophical sense. Theologically, I am well contented to let the Scriptural narrative rest on its appropriate moral evidence, and should only fear to weaken that evidence by mingling it with my own crude scientific speculations. I hold indeed, that Science, by exhibiting to us the independent evidence of analogous convulsions, may well be cited, as removing from that narrative all objections arising from alleged antecedent improbability: but whether the diluvial traces we still observe geologically, be the vestiges of the Mosaic deluge, or whether that convulsion were too transient, &c. to leave such traces, is quite another question.

Before entering more particularly on the examination of the phænomena which indicate the operation of diluvial currents, I would first observe, that the existence of such currents is itself a necessary corollary from the points which have been previously established; and indeed, I am quite unable to conceive any possible geological theory which must not necessarily involve the supposition of such currents.

In the first place it must be universally admitted, that the mass of our continents was originally formed beneath the ocean, and that they have subsequently emerged. Now I would ask, how it can be possibly conceived that this elevation of the continents from the bosom of the waves could have been unattended with violent currents: also, it is nearly impossible that the configuration of the original surface may not have been such, that vast lakes should not have stagnated in many of its portions; these lakes must have subsequently discharged themselves by the disruption of their barriers (as that of Thessaly is traditionally said to have done): hence must have arisen another class of diluvial currents. Again, we find (from examining the dislocations of the strata) that violent convulsions affecting vast masses must have occurred after other portions of the continents had previously emerged. Thus for instance, the Isle of Wight and sixty miles of the adjacent coast have been apparently abruptly thrown on the *beam-ends* of the strata, at a time when we must suppose much of England to have been previously above the sea level. Now I would ask, is it possible to conceive that such a convulsion

* The Atmospheric theory always reminds me of the celebrated line in Coleridge's tragedy:

"Drip, drip, drip, drip; there's nothing here but dripping."

could

could have occurred without creating so violent a disturbance in the level of the then existing sea, as to have caused an immense diluvial wave to overwhelm much of the continents previously emerged?

Having thus seen that the most elementary phænomena of geology necessarily involve the existence of such currents, and that therefore they must be by the same necessity admitted in *every theory whatever* which pretends to account for these phænomena; let us (as in the former part) proceed to examine the case more in the detail.

I. The conglomerate rocks and strata of gravel interposed in several of our geological formations indicate several periods of violent diluvial action, of which the last was more recent than the deposition of all our regular strata, and appears to form the precise limit of demarcation between the epochs of the geological formations and the actual epoch; and in every instance the disposition and distribution of the water-worn materials is such, as to be absolutely incompatible with the theory of their fluvial origin.

Observations.—The British strata which have been most carefully examined present four principal accumulations of water-worn detritus of preceding rocks, and the Continental series, as far as known, appears to be analogous. These deposits are associated: 1. with the old red sandstone; 2. with the lower beds of the new red sandstone; 3. with the plastic clay above the chalk; and 4. they form the most superficial deposit covering all the regular strata. We may examine these in order:—

1. Although we occasionally find beds of a conglomerate texture associated with the grauwacké, yet these appear neither very extensive nor well defined; it being occasionally difficult to distinguish between true pebbles derived from the fragments of previous rocks, and nodules formed in the settlement of a compound mass by the concretion of particular materials round particular centres, through an attraction of aggregation: but in the old red sandstone we often find beds of great extent composed of the conglomeration of indisputable fragments derived from the earlier rocks, and rounded by attrition. The most common of these pebbles are quartz, derived from the veins of that mineral abounding in all the transition formations. We also find fragments of the harder and more siliceous varieties of slate, jasper, greenstone, &c. It would be interesting to compare more fully than has yet been done, the fragments of this conglomerate with the earlier rocks, and thus to trace them to their original habitats. As to the disposition of these accumulations of what must have once been gravel,—as they form extensive beds, they must have been spread

spread abroad by oceanic waves, like the gravel now lining the beaches of our coasts: for it is clear that river courses can only convey gravel over the lines of their channels, or over the flats exposed to their floods. When therefore we find gravel uniformly distributed over extensive plains which we cannot conceive to have been in such a predicament, I see not how we can avoid having recourse to oceanic waves; indeed, comparing the level of these beds with those of the posterior rocks of submarine formation, (so far as the subsequent dislocations and disturbances which have much deranged the relative position of these strata will allow us to make the observation,) we very generally find these masses of gravel deposited beneath what appears to have been the sea level at the epoch of their accumulation. It certainly may be said, on the part of the Fluvialists, that although the distribution of these gravel beds must be referred to oceanic waves, still they may have originated in the action of the rivers traversing the then existing continents, and have been by these rivers transported to the bed of that ocean. That this may have been partially the case is, indeed, true; just as it is with regard to the gravel of our present sea-beaches. But surely in both instances it must principally be referred to the more powerful agent, as we must from the preceding argument be equally convinced of the presence of "Earth-shaking Neptune" in both cases. In the earlier period indeed, there is every reason to believe that the currents of the then ocean must have been much more violent than those which now exist, inasmuch as the dislocations of the strata which appear then to have taken place, are such as cannot be supposed to have occurred without having occasioned the most impetuous waves and diluvial currents by the impulse communicated to the circumfluent waters.

The quartzose conglomerate of the millstone grit incumbent on the carboniferous limestone occurs under circumstances exactly similar, and in geological age so nearly approaches the former, that it seems superfluous to separate it as indicating a distinct diluvial period.

2. The vast beds of conglomerate constituting very generally the lowest members of the new red sandstone, present a still more striking instance of similar phænomena: they form indeed, one of the most magnificent and illustrative of all geological exhibitions. The materials of this conglomerate being generally derived from the most contiguous chains of the older rocks, vary in different districts: thus where the new red sandstone abuts against transition chains of grauwacké, &c. (as in Devonshire,) the pebbles are quartz, hard slates, porphyry, &c. (*e. g.* the celebrated Heavitree conglomerate); where the formation

mation approaches calcareous chains (as along the Mendips, on the Bristol Avon, on the south edge of the South Welsh coal basin, &c.), its materials have been derived from the carboniferous limestone.

In this case the blocks included are often of considerable size, as especially in the section exhibited by the new road ascending Clifton Downs from the end of St. Vincent's Rocks: here they must sometimes weigh several tons. The pebbles exhibit all the characteristic organic remains of the original rock, and the outline of those remains is often truncated by their rounded surface.

This conglomerate has most evidently originally formed beds of gravel lying against the chains whence that gravel was derived, in a manner exactly similar to that of an actual sea-beach; they are thickest at the nearest points to those chains, and regularly decrease as they recede from them. Thus the calcareous conglomerate covering the coal-measures near the Mendip chain is twenty-three fathoms in thickness; about ten miles distant from that chain it does not exceed one or two fathoms, and still further off quite disappears. These deposits forming the lowest members of the nearly horizontal strata (the comparatively undisturbed position of which shows that no material changes of relative level have been occasioned by subsequent convulsion), we may confidently infer from the superior level of the superincumbent lias, oolites, &c. that these gravel beds were distributed beneath the then sea-level; and the extreme dislocation of the subjacent carboniferous rocks, &c. will sufficiently account for violent diluvial currents in the then ocean. When we examine points where sections are presented of these conglomerates resting on the older rocks, we find the edges of the strata of the latter truncated and smoothed, and their surface often irregularly excavated, in a manner which we cannot but ascribe to the operation of such currents.

The Rothe todte liegende of the German geologists is generally identical in age and position with the conglomerates now considered. I can at least answer that this is the case with those portions of it which I have myself examined in the neighbourhood of the Thuringerwalde.

3. We do not meet with any other extensive accumulation of water-worn pebbles in the strata, until we arrive at the tertiary deposits next above the chalk (the gravel associated with plastic clay): we indeed, in the intermediate formations, find some traces of this kind; for instance, in the calcareous grit beneath the coral rag, and in the iron-sand below the chalk; but they cannot be compared with the conglomerates before

described,

described, containing only very small pebbles, such as we may consider at all times to be pretty generally distributed over the channel of the ocean. Now this absence of large water-worn fragments, as well as the circumstances attendant on the instances of their presence, appears to me to furnish data indicating the true theory of their origin; for otherwise, it might be said that the ordinary action of the waves on the sea coast was quite adequate to explain the existence of these gravel beds, without any necessity of having recourse to extraordinary diluvial currents. But if so, why do we not find them universally intermixed among our formations? for at every period there must have been lines of sea coast, and the *ordinary* action on these coasts must, of course, have been constant and uniform. Why, on the contrary, do we only find them among the products of periods which, on independent grounds (the dislocation of the strata), we must conclude to have been epochs of extraordinary convulsions, and of such convulsions as we cannot conceive to have taken place, without having been accompanied by much disturbance in the level of the then existing oceans, and, consequently, by violent diluvial currents? Thus, during the deposition of the oolites and chalk (as we have already observed in the first part of our essay), we observe few, and comparatively trifling indications of the operations of the dislocating forces: and here, also, we find few and trifling indications of diluvial currents. But, as we have already seen, in the tertiary period the convulsions that elevated the strata of the Isle of Wight and the Dorsetshire coasts, and those which elevated much of the Alps, took place; now we may well represent to our minds what must have been the effect of these convulsions on the sea level, if we should, for a moment, endeavour to imagine what would be the consequences of their repetition. Supposing, for example, that a new island, 800 feet high, were suddenly to be protruded from the bosom of the sea on the Lincolnshire coast, and that, at the same time, 60 miles of the adjacent flats on that coast were broken up, and their beds thrown from an horizontal into a vertical position,—what, in such a case, must be the agitation of the waters! would not the resulting flood spread far and wide? and may we not conceive that the diluvial waves would overtop the neighbouring chain of the Wold hills, scoop out deep valleys in them, and reduce much of their materials to the state of gravel?

The gravel associated with the plastic clay is principally composed of flints derived from the chalk strata: it may be well studied in the neighbourhood of London, as it underlies all the elevated grounds of the plain of Blackheath; and may be

be seen in all the pits of Woolwich, Charlton, Chislehurst, and Bexley. It is distinguished from the overlying superficial gravel, by its containing the shells, &c. of the plastic clay. The upper surface of the chalk, wherever it can be examined, appears to have been deeply eroded by the currents which produced this gravel.

4. I cannot better describe the most recent accumulations of gravel, &c., than by abridging Brongniart's excellent article on the "Terrains Clysmiens ou Diluviens," in his Tableau, p. 66, &c.; and I am happy to join to my own arguments the views of a geologist so superior. "These deposits," he says, "are the most superficial of all the rocks of the period immediately preceding the actual epoch: to the common characters which belong to all the formations of alluvial origin (such as are actually proceeding) they join the peculiar feature of presenting themselves under circumstances which *must oblige* us, *of necessity*, to admit great differences, both as to the forms and elevations of the surface of the earth at the period of their deposition from the actual state, and also as to the *mass and force* of the aqueous currents which then prevailed. Sometimes these characters are found in their position, for they present themselves at elevations or distances whither no water-course moved by the actual forces, even the most violent, could ever possibly arrive.

"Sometimes these are distinguished from all actual alluvial deposits by the volume and nature of the fragments which compose them; for they are often of such a volume, that no actual water-course could possibly transport them, and of such a nature, that they cannot be attributed to the rocks of the soil where they are found; but must have been detached from rocks so distant, that they must have been transported by a force, of which, in the actual state of nature, no examples are known, that can fairly bear an application to the objects and localities under observation.

"The organic remains, such as elephants, hippopotami, &c., and the absence of all remains of man and his arts, offer another ground of distinction."

I would only add to these extracts from Brongniart, whose whole article is well worthy of examination by all who wish fully to understand the subject, a few arguments drawn from particular examples.

I have often been truly curious to know whether the writers who ascribe these diluvial phænomena to the actual operations of atmospheric waters draining off the surface of the earth, ever could have attempted to present to their minds any thing like a precise view of the districts in question, and of the phæ-

nomena they undertake to explain: for instance, of the structure of Luneburg Heath, and all the vast diluvial flats of the North of Germany. These are occupied by one vast accumulation of gravel, partly chalk flints, derived, probably, from a zone of that formation, which must originally have occupied this tract (as may be seen from the chalk-pit at Luneburg), but every apparent mass of which has been swept away, and buried beneath its own ruins: but with these are intermingled vast blocks of granite, often as large as small cottages, for which, at a little distance, I have more than once mistaken them;—this granite being derived from the Norwegian mountains, on the opposite side of the Baltic. Now I will attempt to explain all this on the Fluvial theory. First, the rivers now flowing through the North of Germany must have changed their course so frequently, as to have covered, successively, every inch of the North of Germany, since this gravel is universally distributed: and this they must have done, though we do not find from the earliest records preserved of the topography of the country, that they are in the habit of changing their course in the least. Secondly, they must have washed away every projecting mass of the chalk formation, although we do not find that the slightest mound of the most ancient entrenchments in the neighbourhood has been sensibly affected by atmospheric causes for some thousand years. Thirdly, they must have carried blocks of many tons in weight for some hundred miles, though they have now unaccountably left off transporting any thing of more than a few ounces, and that only for short distances. Fourthly, they must have transported these blocks up their currents; since the granite is derived from the opposite side of the Baltic, but the actual course of all the streams is towards the Baltic. I have always admired the seemingly sarcastic ingenuity of the ancient geometricians, in adopting the *reductio ad absurdum* as a mode of demonstration; but I doubt whether even the fertile imagination of these worthy elders ever conceived any thing quite equal to this.

But I will come nearer home. The great plain of London is deeply and universally covered with flint gravel, apparently derived from the chalk ridges of Hertfordshire, &c.: in that plain arise many insulated hills, as Highgate, Harrow, &c., and these hills are equally capped with flint gravel. Now, as no stream (not even Father Thames) can roll gravel up hill, we must suppose that the original surface of the plain was once at the same level as the tops of these hills, in order to allow the chalk flints to have been transported thither: and while things were in this state, we must suppose the then Thames to have changed

changed its course often enough to bear the gravel to all the points now constituting the hill tops, since they are by no means in any single line. Next, we must suppose the Thames still wandering from bed to bed, to have excavated down to the present level, that is, some 400 or 500 feet, a district of several thousand square miles. And lastly, to have universally distributed the gravel over the surface so excavated: yet, since in the time of the Romans, Londinium was already an emporium, the river has been remarkably reclaimed from the fickle habits of its youth, having been ever constant to a single channel; and the camps of that people on Wimbledon Common and Holwood Hill have resisted the atmospheric action of some eighteen centuries, without material degradation.

I have, about a year since, in a paper communicated to the Geological Society on the valley of the Thames, of which an analysis was given in this Journal at the time*, mentioned instances connected with that valley, in which the diluvial pebbles must have been derived from districts having their drainage in directions exactly opposite to that by which they must have been transported to their present locality.

(To be continued.)

XXXVI. *Observations relative to the Origin and History of the Bushmen.* By Andrew Smith, *M.D. M.W.S. &c.*

[Continued from p. 127.]

THE language spoken by the Bushmen is decidedly a dialect or dialects of that in use amongst the Hottentots elsewhere; but in most situations is so altered and modified, as that its origin and dependence can scarcely be traced. Some express themselves almost exactly in the same manner as the Namaquas; others by the same words, only with a peculiar pronunciation, and a third division in a style partly varied by the mode of utterance, and partly by the introduction of new words or expressions either resorted to for the purpose of communicating newly acquired ideas, or with the design of confusing their tongue and rendering it only intelligible to the members of their own communities. Of the three, the latter modification is by far the most general, and forms what is known amongst the colonists by the appellation "Cnese tal." From the plan just adverted to being frequently adopted, and considered as of advantage in carrying on their dangerous and unlawful exploits, very considerable modifications are even cur-

* See Phil. Mag. and Annals, N. S. vol. vi. p. 61.

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rent amongst families or associates themselves; all of which, however, are more or less perfectly understood by the population at large, though very incompletely by strangers, who are well versed in the more regular language upon which such rude and slang jargon is ingrafted. That clapping noise occasioned by various motions of the tongue, and which is truly characteristic of the Hottentot language, is particularly conspicuous amongst the Bushmen, and by many is so incessantly employed, as to make it appear that they gave utterance to no articulate sounds, but only an uninterrupted succession of claps apparently unfitted for conveying any meaning, and yet completely recognised and understood by those to whom they are directed. Lest the foregoing observations, setting forth the dialects of the latter as in a great measure unintelligible to the former, may yet, as has already been the case, be urged in proof of their existence as a distinct race, it may be observed that the modifications in use amongst other tribes would not be understood by the different inhabitants, were it not for the occasional intercourse and association of persons of different divisions, whereby all become acquainted with the discrepancies of each other. Such communications, however, do not generally take place between the Bushmen and other tribes, and consequently the dialects of the latter, instead of having been and continuing to be familiar to others, are distinctly known merely to themselves; and only, if at all, understood by strangers after long and serious consideration. That it is the seclusion and not a radical distinction that renders it incomprehensible, is distinctly evinced by the circumstance of those who live on friendly terms with other Hottentot tribes, and unite more or less therewith, expressing their own words by such a modified pronunciation, as to render them quite intelligible, and to bespeak the same root for all varieties.

Their articles of clothing are very simple, rude, and inefficient. A kaross, somewhat in the form of a mantle, is suspended over the shoulders, and is according to the season of the year, or the temperature of the moment, either permitted to hang loose behind the body, or made to envelope as much thereof as its usual scanty dimension will possibly effect. Such is usually composed of sheep-skin, with the woolly side inwards, and forms almost their only protection against the weather, being required to answer all the purposes of a dress by day, and all the offices of a covering by night. Besides that, both sexes have a more limited and partial one for hiding what the dictates of modesty forbid to be exposed; and though the extent to which such concealment is carried is different in each, yet to a certain extent the same objects are kept in view.

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In the men, a portion of skin, usually either of a jackal or of a wild cat, is suspended in front of the body from a leathern girdle which encircles the loins, and frequently a portion of dried leather hangs from the same behind to conceal at least a portion of the after parts, when the principal article of covering is too short to perform that office. Amongst the women again, the article in question is more extensive, and commonly consists of some ragged skins or pieces of leather, variously fixed together and attached round the loins, thereby enveloping more or less the whole of the parts between those and the middle of the thighs. The members of this sex also universally endeavour to procure some sort of covering for their heads, which they usually compose of the same article as that which forms the other parts of their dress; and if obtainable of sufficient size, apply it somewhat like a turban. The men on the other hand are commonly regardless of the part just adverted to, and generally appear bareheaded, unless when hunting or exposed to the influence of a very strong sun, on which occasions they usually employ a sort of cap made of the dried skin of some animal they may have killed in the chase.

The inefficiency, however, of such clothing induces them to have recourse to other means of protection besides those which have been detailed, and particularly to that of anointing their bodies and limbs with fat, either pure or variously adulterated. In the practice of this, they have always a twofold object in view; namely, the protection of their skin against the parching effects of heat and wind, and the agility and pliability ensured to the muscles and joints; and whatever may be said against the custom, it is certainly a necessary and highly beneficial one to such as are without those complete coverings, which more civilized life supplies. The necessity of often exposing themselves during the great heat of the day, doubtless soon made them aware of the want of some protection against a powerful sun, and suggested the present method they pursue of forming a sort of umbrella by the disposing of ostrich feathers round the extremity of a common walking stick. All, as well male as female, betray a remarkable anxiety after ornaments, and evince a marked desire for every article that appears to them either gaudy or uncommon. Amongst such, the most in esteem are perhaps beads, buttons, and pieces of copper, brass, or polished steel; and what of those they happen to procure, they attach to different parts,—such as the neck, ears, hair, loins, extremities, &c., and not unfrequently also to their different articles of clothing. Indeed so strong is their love of decoration, that they will, in the absence of the more desired objects for that purpose, employ those of their

own

own construction,—such as sashes formed of circular pieces of the shell of the ostrich egg, pieces of wood, teeth of wild animals, shells, young tortoises, &c. and those they display in different positions and forms, according to the fancies of the wearers.

The circumstance of their having no fixed abodes goes to prevent them from having any established huts; and the constant necessity of moving from one place to another in quest of an uncertain and scanty subsistence, inclines them to bestow little care or labour on their temporary dwellings. They either erect a shelter of bushes for the night, under the shade of which they repose, or dig a hole in the ground, into which they creep, or else seek a refuge in some natural crevice of a rock, or under a projecting stone, either of which they consider as quite sufficient for a transient residence. Though such is the general method they follow, in protecting themselves against the effects of the weather during the periods of their repose, yet some are more particular, and extend their consideration so far as to supply themselves with a sort of mat, which they place nearly upright by means of a couple of poles, viz. one at each extremity, and under the protection of that they seek their rest.

[To be continued.]

XXXVII. *Statement respecting the Legacy left by the late Earl of Bridgewater, for rewarding the Authors of Works, to be published in pursuance of his Will, and demonstrative of the Divine Attributes, as manifested in the Creation.* By DAVIES GILBERT, *M.P. V.P.R.S.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

THE following short statement respecting the late Earl of Bridgewater's legacy of eight thousand pounds, and of the final arrangements made in consequence of it, may possibly be thought not unworthy of a place in your Journal.

The Reverend and Right Honourable Thomas Henry Egerton Earl of Bridgewater died in the month of February, 1829, at Paris, leaving his last will and testament bearing date on the 25th of February, 1825, in which he desired and directed his trustees to lay out and invest in their own names in some or one of the public Stocks or Funds of Great Britain, the sum of eight thousand pounds sterling; the said sum with all accruing dividends thereon to be held at the disposal of the President, for

for the time being, of the Royal Society of London, to be transferred, paid and applied, according to the order and direction of the said President of the Royal Society, in full, and without any diminution or abatement whatsoever, in such proportions and at such times, according to his direction and judgement, and without being subject to any controul or responsibility whatsoever, to such person or persons as the said President, for the time being, of the aforesaid Royal Society should or might nominate or appoint and employ. And he thereby declared his will and particular request to be, that some person or persons should be nominated and appointed by the said President, to write, print, publish, and expose to public sale, one thousand copies of a work on the Power, Wisdom, and Goodness of God, as manifested in the Creation; illustrating such work by all reasonable arguments, as for instance, the variety and formation of God's creatures in the animal, vegetable, and mineral kingdoms; the effect of digestion and thereby of conversion, the construction of the hand of man, and an infinite variety of other arguments; as also by discoveries, ancient and modern, in arts, sciences, and the whole extent of literature....And he desired that the profits arising from and out of the circulation and sale of the aforesaid work should be paid by the said President of the Royal Society, as of right, as a further remuneration and reward to such person or persons as the said President of the Royal Society should so nominate, appoint, and employ; with a further power to advance the sums of 300*l.* and of 500*l.* during the writing and printing of the said work.

The testator appointed John Charles Clarmont, Thomas Phillips, and Eugene Auguste Barbier, Esquires, executors and trustees of his will. And these gentlemen, on the 14th of July 1830, invested the devised sum of 8000*l.* in the purchase of 3 per cent. consolidated Bank Annuities, which now stand in their names for the above specified purposes.

The late President of the Royal Society having ascertained from a Noble Lord immediately connected with the deceased, that his family were desirous of having the objects of the bequest executed, proceeded as follows:—

He was fully aware of the duty imposed on him to select persons amply qualified for discharging in an adequate manner the task they would have to perform; and he was also impressed with the conviction, that however carefully a selection might be made, several gentlemen must be omitted, possessing the requisite qualifications, equally, perhaps, with those who received the appointment.

For the purpose therefore of acquiring the most able assist-

ance, and of placing the whole transaction above even the suspicion of favouritism or partiality, the late President was induced to request the aid of two individuals, as highly distinguished by their abilities and by their learning as by the eminent stations which they hold in the hierarchy of the country, where able and intrepid champions have never been wanting to vindicate the natural and moral attributes of the Divinity against the equally dangerous attacks of infidelity, fanaticism, and imposture. The two distinguished prelates, the Archbishop of Canterbury and the Bishop of London, most readily condescended to afford their assistance; and after much deliberation, and with the concurrence of the Noble Lord above alluded to, the work has been placed in the hands of the following eight gentlemen:—

The Rev. William Whewell, M.A. F.R.S., Fellow of Trinity College, and Professor of Mineralogy in the University of Cambridge.

The Rev. John Thomas Chalmers, Professor of Divinity at Edinburgh.

John Kidd, Esq. M.D. F.R.S., Regius Professor of Medicine in the University of Oxford.

The Rev. William Buckland, D.D. F.R.S., Canon of Christ Church, and Professor of Geology in the University of Oxford.

Peter Mark Roget, Esq. M.D., Sec. R.S.

Charles Bell, Esq. F.R.S., Surgeon.

The Rev. William Kirby, M.A. F.R.S.

William Prout, Esq. M.D. F.R.S.

Each being pledged to take a part, as designated by the testator, most adapted to his acquirements and to his pursuits: and thus it is confidently hoped and expected, that a work entrusted to such individuals will appear, as a whole, worthy of the age and of the country about to give it birth.

XXXVIII. *Notices respecting New Books.*

Six Maps of the Stars. Published under the superintendence of the Society for the Diffusion of Useful Knowledge. London, 1830. 4*to.*

WE congratulate our astronomical readers, as well as that large portion of the public which is interested in the science of astronomy, on the appearance of these beautiful maps. They would have formed a valuable addition to astronomical literature, had they been published on terms corresponding with those which works of this description on a similar scale ordinarily bear. But published, as they are, at a price so low as to enable every individual, who feels an interest in the subject, to possess himself of an atlas of all the stars visible

visible to the naked eye, adequate in plan and in execution to the present state of astronomy, their value becomes greatly enhanced. They form, perhaps, in a scientific point of view (with the exception of the Life of Galileo and that of Kepler, each of which must be regarded as being, on the whole, of equal importance to them) the most valuable single part of the works published by the Society for the Diffusion of Useful Knowledge, and the precursor, we hope, of many more, characterized by similar excellence.

The projection according to which these maps are laid down, is that which was suggested, for representing the sphere of the heavens, by Mr. Lubbock, (under whose immediate direction, we understand, they have been executed,) in his paper on the perspective representation of a circle, published in our fifth volume, of the present series. This is the Gnomonic Projection; the stars being projected on the maps in *perspective;* that is, as they would be, if it were possible, at a given moment, by a Camera Lucida. The celestial sphere is thus projected upon six planes, (each of which is represented by a map,) forming the sides of a cube, the eye being supposed to be at the centre. The distortion at the corners is too trifling to interfere sensibly with the effect. The heavenly sphere is thus contained in six maps; and the poles being taken for the respective centres of the upper and lower surfaces of the cube, the sides of the cube are symmetrical, the parallels of declination on them being portions of hyperbolas, and the meridians straight lines; the upper and lower surfaces are also symmetrical, the parallels of declination on them being circles, and the meridians straight lines. From the properties of this projection, these maps have the advantage of enabling any one to find any star or constellation with the greatest readiness; for, as stated in the "Explanation" prefixed to them, those stars which are in the same great circle in the heavens, and therefore appear to be in the same straight line, are still in the same straight line in the map.

The circles of right ascension and of declination for every degree of right ascension and of declination, having been projected agreeably to this method, the stars were laid down, we are informed in the "Explanation," by Mr. W. Newton (author of the well-known globes) from the Catalogue of the Astronomical Society, taking all the stars in that catalogue up to the sixth magnitude, exclusive, which are about all that can be seen by the naked eye. The magnitudes assigned to the stars represented are those of Piazzi, as given in the Catalogue of the Astronomical Society; the difference of magnitude being indicated by the number of "petals" (rays) in the asterisk denoting each star; those which vary in magnitude (taken from Westphal's list, as quoted in the *Bull. des Scien. Math.* for 1827,) being distinguished by the letters Var. placed over them, as well as by a different symbol from that of the invariable stars. The nebulæ, it is stated, are laid down from a catalogue with which the Society was favoured by the kindness of Sir James South, and which had been reduced to the year 1822, by Mr. Mosley, from that given by Messier in the *Conn. des Tems* for 1786, and from the catalogue given by Lacaille, in the same volume, of the nebulæ observed by him in the

southern hemisphere. The former, in these maps, have Messier's number underneath, those of Lacaille have no reference. The planetary nebulæ discovered by M. Struve are also inserted, from his *Catalogus novus Stellarum duplicium et multiplicium.*

The Milky-way is taken from Wollaston's Catalogue, "as far as that catalogue gives its boundary, that is, to about 30° south declination; beyond that," it is observed, "we know no good authority for its limits."

When a star has a Greek letter in the Astronomical Society's Catalogue, this letter is placed against it in the map; when the star has no Greek letter, the number which stands in the second column of that catalogue is used; and in some few cases, when neither of these references exists, the Italic letter which corresponds to the star in the catalogue is employed. Some stars are without either of these references. The double stars have two dots following the reference, as α : Andromedæ; they are taken from Sir James South's Catalogue of Double Stars in the first volume of the *Transactions of the Astronomical Society,* from the catalogue given by the same astronomer in the Philosophical Transactions for 1826, and from M. Struve's catalogue before referred to.

The prefatory explanation, in addition to the statements we have abridged in the foregoing paragraphs, consists only of an interesting extract from the preface to Flamsteed's *Historia Cœlestis,* respecting the *figures* assigned to the constellations, and which contains nearly all that is known of their history. The figures assigned to them by that astronomer, after a careful examination of Ptolemy's Catalogue, which is the most ancient work in which they are found, (although it is manifest from Ptolemy's statement that similar figures had been used from a period long anterior to his,) have been closely adhered to in the present maps, having been copied from Flamsteed, for this purpose, by Mr. W. Clarke. The maps have been engraved, with great clearness and precision, as well as delicacy of touch, by Messrs. J. and C. Walker; and from the union of these qualities, they have an appearance of beauty and softness unusual in maps and engraved linear representations of scientific subjects, while they are at the same time perfectly adapted—by the distinctness of every line and symbol —for reference and consultation. Their size is ten inches and a half by about ten and three quarters, being very nearly the same as that of the Society's Geographical Maps. Nos. 1 to 4 are occupied by those portions of the northern and southern celestial hemispheres which extend to about 40° of north and south declination; No. 5 includes the stars circumjacent to the North Pole; and No. 6, those which are circumjacent to the South Pole.

Having so fully expressed our approbation of this celestial atlas, an extension of which by a series of maps including stars up to the twelfth magnitude, we are glad to hear, has been determined upon by the Society, we may be permitted to mention an omission or two which we have observed in it. In the "Explanation" the only authorities cited for the *Nebulæ* are Messier and Lacaille as noticed above, the latter for those of the southern hemisphere; and these

appear

appear to have been the only authorities employed in laying down those objects. But in the Philosophical Transactions for 1828 is a catalogue of 629 nebulæ and clusters of stars in the southern hemisphere, observed at Paramatta by Mr. Dunlop, no use of which appears to have been made in the construction of these maps.

Lacaille, we believe, observed only about 40 or 50 nebulæ and clusters of stars in the southern hemisphere; 26 of which, besides the *Nebula Major* and *Nebula Minor*, are given. Now although a large number of those described by Mr. Dunlop may be too small, (like the remainder of Lacaille's,) to be laid down in the present series of maps, and may require to be reserved for that which, as we have mentioned, is now in preparation, yet it seems probable that out of nearly 600 nebulæ and clusters observed *solely* by Mr. Dunlop, some must be equal in apparent magnitude to the 26 of Lacaille's which have actually been inserted, and must therefore require insertion in the present series equally with them.

The "Planetary Nebulæ" discovered by Struve, of which it is remarked in the "Explanation" that "they deserve to be reckoned amongst the most interesting objects in the heavens," have with great propriety been inserted; and No. 8 of Struve is the only one of them which appears in the maps representing the southern hemisphere. Now Nos. 266 and 267 of Dunlop probably belong to this interesting class of bodies, especially the latter.

Annexed to Mr. Dunlop's Catalogue are two elaborate plates, very correctly laid down from observations, of the *Nebula Major* and *Nebula Minor*, no use of which seems to have been made in representing those nebulæ in the maps. In Mr. Dunlop's plates their forms appear to differ considerably from those given in the maps; and the places assigned to them by Mr. Dunlop, differ from those given by Lacaille. In laying down the Milky-way, Mr. Dunlop's detailed map of it, from the Robur Caroli to Scorpio, does not appear to have been referred to. Lacaille is quoted in the "Explanation" as the only authority respecting the dark space in the southern cross; and this phænomenon, it is observed, "does not seem to have been attended to in any celestial globes or maps." This also is particularly mentioned by Mr. Dunlop, and is very accurately laid down by the telescope in his map of the Milky-way.

If we are correct in our estimation of the value of Mr. Dunlop's observations, and if also the Society for the Diffusion of Useful Knowledge should agree with us in the propriety of introducing such of their results as come within the range of magnitude of the present maps, in future impressions, probably, the omissions which we have noticed will be supplied. [B.]

XXXIX. *Pro-*

XXXIX. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Jan. 13 & 20, 1831. A PAPER was read, On the Equilibrium of Fluids; and the figure of a homogeneous Planet in a fluid state; by James Ivory, Esq. A.M. F.R.S.

The author considers the essential property of a fluid, and that on which its definition should be founded, as consisting in the perfect mobility of its particles among one another. If abstraction be made of the force of gravity, or other accelerating force, when a continuous fluid is at rest, and consequently in a state of equilibrium, all its particles are equally pressed in every direction, are equally distant from one another, and are similarly arranged about every interior point. No fluid is absolutely incompressible; but the degree of compressibility may be conceived to be so small as not to affect the results; and it is accordingly disregarded in the investigations which occupy the present paper.

These investigations are built on the assumption that the hydrostatic pressure at every point of the fluid is the same function of the three rectangular co-ordinates of the point drawn to three planes intersecting one another at right angles. The author shows that the algebraical expressions of the accelerating forces producing the pressure are not entirely arbitrary; because they must necessarily be equal to the partial differential co-efficients of a function of three independent variables, and therefore they are likewise the same functions of the co-ordinates of their point of action in every part of the mass. This is one of the conditions required for the equilibrium of a mass of homogeneous fluid; and a second necessary condition is, that these functions of the ordinates are capable of being integrated. When these two conditions are fulfilled, the determination of the figure of equilibrium is reduced to a question purely mathematical. For we can form an equation expressive of an equilibrium between the accelerating forces and the variation of pressure, and by integrating this equation we may obtain the hydrostatic pressure; whence may be deduced the equation of all those points at which there is no pressure, that is, of the outer surface of the fluid. All that is then requisite for securing the permanence of the figure of the fluid, is that the pressures propagated through the mass be either supported, or mutually balance one another. The upper surface, which is at liberty, and where there is no pressure, and all interior surfaces, where the pressure is constant, have the same differential equation; and from this the author infers that such surfaces are perpendicular to the resultant of the accelerating forces acting upon the particles contained in them. These interior surfaces were denominated by Clairaut *level surfaces;* and they are distinguished by the two properties of being equally pressed at all their points, and of cutting the resultant of the forces at right angles.

The author next extends the investigation to heterogeneous fluids, the different parts of which vary in their density, and deduces a similar

milar conclusion to the former with respect to the perpendicularity of the interior level surfaces to the resultant of the accelerating forces, which act upon the particles situated in each surface respectively. He discusses the hypothesis of Clairaut, of narrow canals traversing the mass in various directions, and shows that the same results follow from it as from the general theory.

The conditions laid down by Clairaut, and all other authors, as those which are necessary for the equilibrium of a homogeneous fluid, are these two:—first, the accelerating forces must be expressed by the partial differential co-efficients of a function of three independent co-ordinates; secondly, the resultant of the forces in action at the upper surface at liberty must be perpendicular to that surface. The author shows that the second condition is a consequence of the first; and he states the independent conditions of equilibrium to be these:—first, the expressions of the forces must be the same functions of the co-ordinates in every part of the mass; secondly, the same expressions must be the partial differential co-efficients of a function of three independent co-ordinates.

In a very extensive class of problems, the difference in the two ways of laying down the conditions of equilibrium disappears. But the theory of Clairaut cannot be extended to the cases in which the particles mutually attract or repel one another, or where the accelerating forces depend on the figure of the mass of fluid. Such is the condition of a homogeneous planet in a fluid state, in which there are forces which prevail in the interior parts, but vanish at the surface; and which are, therefore, not taken into account in Clairaut's theory. But since these forces tend to change the figure of the fluid, that theory is inadequate to give an exact determination of the equilibrium in those cases.

In the second part of the paper, the author applies his theory of the equilibrium of fluids to the determination of the figure of the planets, under the supposition that they are composed wholly of fluid materials. For this purpose he first considers the problem of determining the equilibrium of a homogeneous mass of fluid entirely at liberty, when the accelerating forces are known functions of the co-ordinates at their point of action. In the investigation of this problem, he supposes that the centre of gravity is at rest, and undisturbed by the action of any accelerating force. He then supposes the fluid to be in equilibrium, and that three planes are laid down, intersecting one another at right angles in the centre of gravity of the mass, to which planes the particles of the fluid are referred by rectangular co-ordinates. The algebraical consequences of this supposition are then pursued, the conditions necessary to equilibrium pointed out, and the conclusion deduced, that the resultant of the accelerating forces is perpendicular to the outer surface, and also to the interior level surfaces of the fluid, at every point of which there is the same intensity of pressure. The figure of the fluid being determined, it remains to inquire, whether the equilibrium is secure; and the result of the inquiry furnishes an equation which proves that the particles have no tendency to move, from any inequality of pressure.

A further

A further discussion is entered into in order to prove that the pressures propagated from the surfaces into the interior parts balance and destroy one another, which completely establishes the permanence of the figure of the fluid. It is also shown that the mass of fluid, under these circumstances, has no tendency to turn upon an axis.

To illustrate the foregoing problem, the author applies it to the determination of the figure of equilibrium of a homogeneous mass of fluid entirely at liberty, of which the particles attract one another with a force directly proportional to the distance, at the same time that they are urged by a centrifugal force caused by rotation about an axis.

He then enters upon the investigation of the second problem, in which the law of attraction of the particles is that of the inverse duplicate ratio of the distance; and finally arrives at the conclusion, that the form of the fluid in equilibrium is, exclusively of all other figures, an oblate elliptical spheroid of revolution, and that its axis of rotation is the lesser axis of the spheroid. He also shows that within the spheroid there are no more than two sets of surfaces equally pressed by the action of the exterior fluid; and no more than two different spheroids of equilibrium answering to the same rotatory motion. If the whole spheroid be one of small oblateness, the greatest of the interior surfaces of equable pressure, which is not a level surface, stands upon the equator; and the rest are within this, and are similar to it, and similarly posited. When it is very oblate, the greatest of these surfaces is described about the lesser axis; and the rest are within it, and are similar to it, and similarly posited. The existence of two sets of interior surfaces, that are equally pressed at all their points by the action of the exterior fluid, is inconsistent with Clairaut's theory, and is a proof of its insufficiency for determining the figure of a homogeneous planet.

Jan. 27.—A paper was read, On the probable electric origin of all the phænomena of Terrestrial Magnetism, with an illustrative experiment; by Peter Barlow, Esq. F.R.S. Corr. Mem. Inst. France, and of the Imp. Acad. St. Petersburgh.

The author begins his paper by a retrospect of the several discoveries on terrestrial magnetism made since the commencement of the present century. Humboldt, by his numerous and accurate observations on this subject, laid the foundation of all the scientific knowledge relating to it, which we hitherto possessed. The task of reducing these observations to definite principles, by subjecting them to calculation, was undertaken by Biot; and the conclusion which he drew from them was, that, on the hypothesis of the earth's being a great magnet, the facts would best accord with the supposition that its two poles are coincident, or indefinitely near to each other, at the centre of the globe. The same result was also obtained, though by a different process of reasoning by M. Kraft of St. Petersburgh. It followed as a necessary consequence that terrestrial magnetism observes a law different from that of a permanently magnetic body, but identical with that of a body in which transient magnetism is excited by induction. The law which obtains in the case of a sphere of iron rendered

rendered magnetic by induction was first investigated, in 1829, by Mr. Barlow; and also, by Mr. Charles Bonnycastle, Professor of Mathematics in the University of Virginia; it has since been amply confirmed by the more elaborate analytical investigations of Poisson. But the result of all these inquiries, instead of affording us clearer notions of the action of terrestrial magnetism, tended rather to perplex and obscure our views respecting its nature and operation.

While our knowledge was in this imperfect and almost retrograde state, a new light broke in upon us in the great discovery of Oersted, which, by disclosing the intimate relation which electricity bears to magnetism, must be regarded as forming a new era in the history of this department of physical science. The operation of the tangential force between a galvanic wire and a magnetic needle was pointed out by the author, in a paper which was read to the Royal Society in the year 1822; and was still more fully examined by M. Ampère, who extended the investigation to the law of the reciprocal action of galvanic currents on one another; and thence deduced a general theory of magnetic action.

Having established the general fact that the magnetism which is induced on an iron ball resides only on its surface, and acts according to the same laws as the magnetic influence of the earth, the author was desirous of ascertaining whether he could succeed in imitating the effects of terrestrial magnetism by distributing galvanic currents round the surface of an artificial globe. This conjecture he put to the test of experiment, by having a hollow wooden globe constructed, sixteen inches in diameter, with grooves cut at all the parallels of latitude distant by 10° from each other. Copper wires were then laid in these grooves, and disposed so as to allow of the transmission of a galvanic currrent in similar directions through the whole system of these circular wires. This being effected, it was found that a magnetic needle, properly neutralized, so as to be exempt from all influence from the earth, and freely suspended in different situations on the surface of this artificial globe, assumed positions exactly analogous to those of the dipping-needle in different parts of the earth. The author has no doubt that if the electrical currents in this experiment could be increased indefinitely, the apparatus might be made accurately to represent every circumstance of magnetic dip and direction actually observed in nature.

It thus appears that all the phenomena of terrestrial magnetism may be produced by electricity alone: for it is evident, that in place of the needle employed in the experiment above described, the galvanic needle of Ampère might have been substituted, to the complete exclusion of the only magnetic part of the apparatus.

The discovery of Seebeck, that heat applied to a circuit of metallic conductors developes galvanism, and consequently gives rise to magnetic induction, supplies another link in the chain of evidence, that terrestrial magnetism is purely an electrical phenomenon, deriving its origin, during the diurnal revolution of the earth, from the action of the sun's rays on successive portions of its surface, in directions parallel to the equator. The probability, therefore, is now

much increased, that magnetism is a quality not essentially distinct from electricity.

Feb. 3.—A paper was read On the Lunar Theory. Communicated by the Rev. Dr. Lardner, F.R.S.

The subject treated of in this paper is introduced by a review of the labours of Clairaut, Euler, D'Alembert, and Thomas Simpson. The theories of these eminent men, the author remarks, were very deficient in accuracy, and were not at all adequate, without correction from observation, to the construction of tables. They could serve only to point out the arguments of the equations, and not all even of these. The inequalities of the moon's motion are investigated by approximating processes, which lead to results more or less accurate, according as the approximations are carried to a greater or less extent. The writers above mentioned had contented themselves with short and easy approximations; and though they had accomplished much, had yet left much more to be done. Subsequently to these, Mayer published an elaborate theory of the moon; but his coefficients required much correction, the results of his computations being in some cases found to differ very widely from observation. A much greater degree of accuracy was attained by Laplace, who bestowed particular attention to the influence of minute quantities, in every part of his theory. In the present paper the author has endeavoured to introduce further improvements into the lunar theory, by carrying the approximations considerably further than had hitherto been accomplished.

In the solutions of the problem given by former mathematicians, the chief obstacle to the attainment of accuracy was the extreme length and labour of the necessary computations. Another object, therefore, which the author has had in view, is to facilitate these computations, and render them less laborious. This he endeavours to effect by the employment of certain artifices, by which the multiplicity of small terms will, with their coefficients, be reduced within a practicable compass, and their numerical computation rendered less appalling.

The coefficient of the equation depending on the moon's distance from the sun, affords the means of calculating the sun's horizontal parallax. For this purpose Laplace has computed this coefficient with greater accuracy than the rest; and he makes the sun's parallax nearly $9''$. The author's theory gives it little more than $8\frac{1}{2}''$, which is very near the mean of the various results obtained by the observation of transits. He thinks that there is, therefore, great reason to conclude that its true value is about this quantity.

LINNÆAN SOCIETY.

Feb. 1.—A. B. Lambert, Esq. in the chair.

A communication from John Blackwall, Esq. F.L.S. was read, intitled Remarks on the Pulvilli of Insects. In this paper the writer controverts the statement of Dr. Derham in his Physico-Theology, supported by Sir E. Home, and generally adopted by naturalists, that the feet of flies and other insects are furnished with "skinny palms," which enable them to stick on glass, &c. by means of the pressure of

the atmosphere. Mr. Blackwall states that he found that minute hairs very closely set and directed downwards so completely cover the inferior surface of the expanded membranes, improperly called suckers, with which the terminal joint of the tarsi is provided, that it cannot possibly be brought into contact with the objects on which these insects move. He concludes, from observation and experiment, that the insects traverse the vertical sides of smooth bodies, by means strictly mechanical, as Dr. Hooke had suggested.

Feb. 15.—The reading of Mr. Blackwall's paper on Spiders was concluded.

GEOLOGICAL SOCIETY.

Jan. 5. 1831.—A paper was read entitled, "On the general structure of the Lake Mountains of the North of England, and on the great dislocations by which they have been separated from the neighbouring chains;" by Prof. Sedgwick, Pres. G.S.

The country, of which the author hopes to give a detailed description in a series of communications, is bounded to the west and the south by the waters of the Irish Sea and Morecambe Bay. Towards the north it descends into the plain of the new red sandstone within the basin of the Eden; and on the east side it presses against, and partly encroaches on, the central carboniferous chain of the north. Within these limits are found two distinct classes of rocks, all the central region being composed of crystalline unstratified rocks, irregularly associated with great formations of schist, which are subdivided (agreeably to the system first published by Mr. Otley of Keswick,) into three well defined groups; while on the outskirts of these older formations is a broken zone of carboniferous limestone, and extensive deposits of superior [secondary] strata. The author avoids all mineralogical details; and after noticing the effects produced by the several formations on the external features of the country, describes at great length the range of a band of transition limestone (from Millam in Cumberland, to the neighbourhood of Wasdale Head in Westmoreland) nearly across the whole physical region under consideration; and states that it is finally cut off by a protruding boss of granite, which he regards as newer than the limestone. Upon this description he founds the following conclusions.

1st. Great cracks and fissures were formed at a very ancient period, diverging from the central regions, and intersecting the line of bearing of the strata. All the great valleys in the range described, are scooped out in the prolongation of these breaks, which were in all cases accompanied with internal movements; the present position of the systems of strata on the opposite sides of a transverse valley sometimes indicating a relative lateral movement of more than a mile in extent. These singular changes of position are referred partly to a true lateral shift, and partly to subsidence. Reasoning from analogy, the author concludes that all the great diverging valleys of the Lake Mountains took their origin in fissures probably formed during the period of the protrusion of the central syenite and granite.

2ndly. He observes that the upper and lower systems of the slate

 rocks

rocks are often violently contorted; while the central system, though cracked and fissured as above described, hardly ever exhibits the indications of any flexures. This is explained by the presence of enormous unbending masses of compact felspar, porphyry, &c., which are so intimately associated with the middle division of the slate that the formations cannot be separated. The appearance is explained by referring the felspathic rocks to some modification of sub-marine volcanic action; by supposing that igneous and aqueous causes acted together, and that the operations were many times repeated.

3rdly. The mean line of bearing of the different systems is shown to be nearly N.E. by E., and S.W. by W. This makes them, one after the other, to abut against the carboniferous zone; from which it follows that they must also be unconformable to it. The author confirms this inference by referring to detailed sections; and, from the whole of the evidence, he concludes, that the central Lake Mountains were placed in their present position,—not by a long-continued, but by a sudden movement of elevation, before or during the period of the old red sandstone.

Lastly, He enters into some details, from which he endeavours to show, that if lines be drawn in the principal bearing of the following chains (viz. the southern chain of Scotland from St. Abbs Head to the Mull of Galloway; the grauwacké chain of the Isle of Man, the slate ranges of the Isle of Anglesea; the principal grauwacké chains of Wales, and the Cornish chain), they will be nearly parallel to each other, and to the line of bearing of the Lake Mountains, as above indicated. The elevation of all these chains is referred to the same period; and the parallelism is not regarded as accidental; but as a confirmation of one of the great principles upon which are founded some of the most beautiful generalizations of the Essays recently published by M. Elie de Beaumont.

The author next describes the system of faults by which the Lake Mountains were broken off from the central carboniferous chain. After some speculations on the original extent of the carboniferous deposits, which were spread out from the Scotch border to the central plains of England, and perhaps continuous with the similar deposits on the Bristol Channel, he points out some peculiarities of the western coal-fields.

1stly. The axes of the several contemporaneous basins are not parallel.

2ndly. The causes which produced this arrangement appear to have partially affected the then neighbouring grauwacké regions. Thus the transition slate of North Devon does not range parallel to the mean bearing of the grauwacké chain, but to that of the Welsh coal-field.

3rdly. These coal-fields are contrasted with the carboniferous chain of the north, extending from the latitude of Derby to the mouth of the Tweed: and it is inferred, from the nature of the beds resting on the edges of the dislocated strata, that the elevations of the south-western and northern systems were not perfectly contemporaneous.

4thly. The

4thly. The coal-fields of the Bristol Channel have no well-fined line of bearing, and have produced but small effects on the range of the superior secondary formations, which from the south coast to the latitude of Derby are nearly parallel to the mean range of the grauwacké chains above indicated. On the contrary, the great carboniferous chain north of Derby has produced a direct influence on the bearings of the newer formations.

He then briefly describes the structure of the great carboniferous chain of the North of England. The forces of elevation appear on the whole to have acted (though not without considerable deviations) on a line bearing nearly north and south. The position of the High Peak limestone, and the great north and south faults on its western side, are first noticed; and the axis of elevation is continued by help of an anticlinal line through the region of millstone grit, separating the Yorkshire and Lancashire coal-fields. The reappearance of the carboniferous limestone, its high elevation, and prolongation to the Scotch border, and the faults which range near its western escarpment are then noticed; and the great Craven fault (described in detail by Mr. Phillips) is traced still further towards the north from the hills of Barbondale to the foot of Stainmoor. The nature of the dislocations is illustrated by sections; and it is shown that the prolongation of the Craven fault from Mollerstang, to Stainmoor foot has thrown down the carboniferous system with an inverted dip into the valley of the Eden, and produced a dislocation precisely similar in kind to that near Ingleton, described in detail by Mr. Phillips, and indicated in one of Mr. Conybeare's sections.—It is further shown that these dislocated mountain masses, becoming more expanded and less inclined, are prolonged without any further break of continuity into the northern zone of the lake mountains. A great fault which ranges at the foot of the Cross Fell Chain, and meets the Craven fault at the foot of Stainmoor at an obtuse angle, is then described; and it is shown that when it strikes the carboniferous chain above Brough, an effect is produced precisely similar to that which accompanies the prolongation of the Craven fault. By the intersection of these faults, the very complex relations of the mountain masses, in the last ramifications of the Eden, and the insulated position of the Lake mountains are at once explained.

Lastly. The author speculates on the origin of the phænomena described, and points to the different crystalline rocks appearing near the carboniferous chain. He proves that the great breaks took place immediately before the oldest deposits of the new red sandstone, and endeavours to show that they were produced by a violent and transitory, and not by a long-continued action.

Jan. 19.—The reading of a paper, entitled "Supplementary Observations on the structure of the Austrian and Bavarian Alps," by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S. was begun.

Feb. 2.—The reading of the paper, by Roderick Impey Murchison, Esq. Sec. G.S. F.R.S., begun at the last Meeting, was concluded.

This

This memoir contains the results of observations made by the author during last summer, with the view of extending the researches of Professor Sedgwick and himself*: the present remarks being limited to the consideration of that portion of the Alps, on the northern side of the axis, which is included between the lake of Constance on the west, and Vienna on the east, followed by a short description of the valley of the Danube.

1. *Primary Rocks.*—He notices that Mr. Partsch and himself discovered that traces of the primary axis of the Alps reappear in the Leitha-gebirge, and are there overlaid on each side by tertiary deposits.

2. *Transition Rocks with Iron Ores* are briefly alluded to, merely for the purpose of marking their place in the series.

3. *Rauchwacke or Magnesian Limestone.*—The author shows that the formation is much developed near the eastern termination of the Austrian Alps, (St. Johann, Kirchbüchel, Söbenstein, &c.) that it there dips under red sandstone and Alpine limestone, and is quite similar to rocks occupying the same position in the Tyrol (Schwatz, Söll, &c.).

4. *New Red Sandstone with Salt and Gypsum.*—In former sections, (published by Professor Sedgwick and the author,) this formation is only designated in one line of valleys, i. e. along the great escarpment of the Alpine limestone; recent observations have, however, convinced the author, that it is reproduced in other longitudinal depressions, further removed from the axis of the chain. In the valley of Abtenau, for instance, he ascertained that the red sandstone containing thick masses of gypsum and several salt-springs, dips conformably on one side under black shale and limestone, of the age of the lias, and on the other is overlaid unconformably by the shelly deposits of Gosau. He also cites Berchtesgaden, with its salt-mines, as another case of a valley in which the new red-sandstone is denuded, and he shows that the strata there dip beneath the whole of the oolitic series of the Kneifelberg and Untersberg.

5. *Lower Alpine Limestone, or Lias and Inferior Oolite.*—It is stated that the dark-coloured limestone and shale which surmount the red sandstone at Abtenau, range northwards with various contortions, and are well exposed in the gorge of the Mertelbach below Crispel; where, accompanied by M. Von Lill, the author collected several fossils, viz.: Ammonites, two species, (one very near to *A. Conybeari*,) Pecten, three species, small Gryphæa, Mya, Perna, two species, Ostræa, Corallines, &c. In mineral characters these beds, it is said, closely resemble some of those of Whitby, from which, together with the complexion of the fossils, and their place in the series, the author refers the group to the lias. An

* Prof. Sedgwick and Mr. Murchison's paper on the Austrian Alps, here alluded to, will be found in the *Philosophical Magazine and Annals*, vol.viii. p. 81.—Edit.

overlying

overlying red, encrinite limestone, contains at least five or six species of Ammonites and some Belemnites; amongst the former is the *A. multicostatus*. This red limestone crops out on both sides of the valley of the Salza near Hallein, and reappears in various places in the Salzburg Alps (Aussee, Ebensee, &c.).

6. *Salt Deposits.*—The place assigned to most of the salt-mines of the Austrian Alps in the memoir of last year, has been confirmed; and additional sections are given at Halstadt and Aussee to prove that the salt masses in these places are fairly encased in Alpine limestone. In other localities, however, as above indicated, this mineral is shown to occur in the same formations as in England.

7. *Upper Alpine Limestone, or Upper Oolite.*—In this group the author comprehends semi-crystalline, brecciated, scaly, compact and dolomitic limestones. The Hippurite limestone, though with some doubt, is considered to mark the superior limit of this series, the author having been led to this conclusion from the relations seen on the north flank of the Untersberg, at Windischgarsten, Gosau and the Wand, in all of which places there are passages from the Alpine limestone into the Hippurite rock.

8. *Sandstone, Calcareous Grit and Shales, Slaty Limestone, &c.*—The *Gres de Vienne* is placed by the author as the lowest member of this group; although in the eastern termination of the Alps he agrees with M. Boué, that its separation from the Alpine limestone cannot well be effected. All along the chain, however, from the Enns to the lake of Constance, he thinks that the grits and shales with fucoids constitute a natural group distinguished in external characters from the Alpine limestone, and that they there form the lowest term of the green sand. He then describes several transverse, parallel sections across that zone. The first of these is in the valley of the Allgau or Sonthofen, in the upper end of which, near Mieselstein, the grits and fucoid shales are broken through by gneiss, which appears to have been heaved up in a solid form posterior to the deposition of the former; whilst in an adjoining gorge dikes of igneous rocks seem to have made unavailing efforts to pierce through the overlying mountain of the Schwarzenberg. The dislocations and inversions of dip in the parallel ridges of the Allgau are described in detailed sections. At the mouth of the valley the Grinten, a narrow serrated mountain, ranging E.N.E. and W.N.W., is composed of many of the same rocks described last year at Nesselwang, but owing to a complete reversal of dip the lowest beds or inferior green sand are thrown into juxtaposition with a ridge of conglomerate of tertiary age, which dips to the north beneath the molasse of the plain. The lowest beds are nearly vertical, and consist of brown chert; these are succeeded by green, calcareous sandstone and grit highly inclined, containing *Inoceramus concentricus*, *Mya plicata*, *Plicatula pectinoides*, a small Gryphæa, Ammonites and Belemnites,—fossils characteristic of the middle and lower green sand. The overlying strata are a cream-coloured limestone with ammonites, passing up into a slaty red marly limestone undistinguishable from *Scaglia*. The formations seen in the Grinten, therefore,

therefore, are a part of the lower, all the upper green-sand, and probably a portion of the chalk.

9. *Lower Nummulitic Limestone and Shale, &c.* (*Sonthofen Iron Ores*).—The strata containing the iron ores at Sonthofen surmount the preceding series in the gorge of the Starzlach. The author considers them, from the character of their fossils, particularly Spatangi, certain species of Nummulites, Belemnites, Terebratulæ, and Trigoniæ, to be more connected with the cretaceous than with the superior formations. To show the essential difference between the age of these iron ores of Sonthofen and those of the Kressenberg, a detailed section is described from south to north on the banks of the Traun, where a vast thickness of lower, nummulitic, calcareous grit, with shales, marls, and cretaceous beds, as exhibited in vertical strata opposite the town of Arzt, are shown to be of the same age as those of Sonthofen, and are clearly proved to be overlaid by the nummulitic iron ores of the Kressenberg.

10. *Upper Nummulitic Iron Ores.*—It is to the shelly iron ores at Kressenberg, and not to those of Sonthofen, that Professor Sedgwick and the author assigned the place of *transition-tertiary* beds,—a place, the correctness of which, it is contended, is now established as clearly by the evidences of superposition, given in this memoir, as it formerly was by Count Münster, from the vast predominance of tertiary fossils.

The natural section on the Traun is then completed, by showing that the *transition-tertiary* beds are conformably overlaid by inclined strata of pebbly sandstone and marls, in the higher part of which, near Traunstein, there are a number of shells unquestionably of tertiary age. All these inclined strata are capped by a thick range of horizontal coarse conglomerate. Sections made on the flanks of the Untersberg confirm the observations of the previous year, and show the Hippurite limestone dipping under the green sand and shale,—the green sand and cretaceous beds surmounted by a vast thickness of nummulitic, green grit; and this again overlaid by blue marls with shells of the age of Gosau and Kressenberg *.

Other localities are noticed, where detached remnants of both the lower and upper nummulitic groups were visited by the author, (St. Pancratz, Mattsee, &c.), and the Gryphite abounding in these beds is stated to be *not* the *Gryphæa columba*, but a new species. Through the labours of Mr. Lonsdale, eight species at least of Nummulites have been distinguished, some of which characterize the lower or secondary strata at Sonthofen, Arzt, and Mattsee, others together with a coral (*Nummulina complanata*) prevail in the *transition-tertiary* groups of Kressenberg, Schweiger Mill, &c. Having thus, both by superposition and by fossils, shown the existence on the flanks of the chain of a deposit with a predominance of tertiary and very few secondary shells, as distinguished from a lower group

* This section as given last year was necessarily terminated by the river Saal, because the Högl on its northern bank consists of an unconformable mass of secondary grit and shale (green sand), which is thrown off from the Stauffen, a promontory of Alpine limestone.

in which secondary fossils prevail, the author proceeds to point out accumulations of the same age, at various heights, within the great secondary chain of the Alps.

In the valley of Gosau several new facts are enumerated. The edges of the shelly deposit are seen to rest on red sandstone, on Alpine and Hippurite limestone, and on green sand. Besides the underlying conglomerate *, the shelly system is considered to be clearly divisible into two parts, of which the inferior contains many secondary as well as tertiary fossils, with Tornatella (Turbinellus, Sow.), Nerinea, rolled Hippurites, &c.; whilst the superior blue marls abound with myriads of shells of a tertiary aspect, and many corals, of species figured by Goldfuss, from the tertiary formations at Castel Arquato, Bassano, &c.

As all the conchologists who have seen the unmixed shells of these upper blue marls have declared that they belong to formations newer than the chalk, the author conceives this case, therefore, to be now established beyond dispute, both by stratigraphical and zoological evidence: and he further is of opinion that the slaty overlying psammites of the Horn and the Ressenberg clearly represent the molasse.

A case of more extraordinary elevation than that of Gosau was this year discovered by the author, in the Alpine pasturage of Zlam above Aussee and Grundelsee, where blue marls with Cerithea, sharks' teeth, &c., overlie calcareous grits and conglomerate, with Tornatella and Nerinea, and are carried up in a cleft of Alpine limestone to at least 6000 feet above the sea. Several localities mentioned by Dr. Boué are then alluded to: Windischgarsten is a valley similar to Gosau, of which, according to the author, it exhibits only the lower shelly beds, and amongst the contiguous rocks on which these repose, are grits, fucoid shales, Hippurite limestone, younger Alpine limestone, &c.

Formations of the *transition-tertiary* age are then described on three sides of the Wand, a mountain of Alpine limestone, at the eastern extremity of the Alps, where the author made various sections assisted by Mr. Partsch of Vienna. At Piesting Meyersdorf, Dreystetten and Grünbach, they found that the shelly, blue marls invariably occupied the same place in the series as at Gosau. At Grünbach, the ascending order, as seen in vertical strata, is Alpine and Hippurite limestones, green grit and shale, coal beds with freshwater shells, nummulitic grit, marls with Gosau shells and corals. In none of these sections could Mr. Partsch or the author detect the trace of Belemnites, said to have been found here by Dr. Boué.

II. *The memoir next describes the valley of the Danube.*

It is stated that the phænomena on the flank of the Bohemian chain, even where it approaches very near to the Alps, are entirely different from any that have been previously described.

In a section from Vilshofen, on the Danube, to Schaerding, true chalk with flints and characteristic fossils is seen, at Ortenburg, rest-

* See former Memoirs.

ing horizontally on black granite. The surface of this chalk is corroded, and the fissures are filled, and covered by sands with oysters, and these again by blue marl, all wearing the aspect of the lower tertiaries in England. These beds in the Inn-kreis, at Pielach near Mölk, &c. &c. stretch *horizontally* round promontories of gneiss and granite, and offer a remarkable contrast to the *verticality* and dislocations of the strata of the same age in the opposite and principal chain of the Alps.

These discrepancies of arrangement, when coupled with the differences in the direction of the two chains, are cited as corroborating some of the views of M. Elie de Beaumont: for the Bohemian mountains trending from N. W. to S. E. are seen not to have been moved from a very ancient period; whilst the principal chain of the Alps running from W.S.W. to E.N.E. is found to have undergone one of its last convulsions posterior to some of the most recent accumulations.

The tertiary deposits in the valley of the Danube and basin of Vienna are cursorily enumerated. At Pielach and other places near Mölk, the lower blue marl or "Tegel" alternates with, and is surmounted by, yellow sand; and the lowest beds of this system are presumed to be the equivalents of the London clay and lower Subapennines.

The middle and higher tertiary deposits are alone well seen in the basin of Vienna, and this the author attributes to the gradual declension in the height of the Alps in their range to the east, by which the older tertiaries, which rest on their edges, are not brought to day in that neighbourhood. These lower beds have, however, been reached by borings near Vienna, where 300 feet of the inferior blue *Tegel* have been traversed, even to the white sands. The *lower* blue marl is covered by yellow sands containing many species of shells, and this again passes up into upper blue marl.

It is from these upper sands and marls, although of not half the thickness of the lower, that nearly all the known shells of the basin of Vienna have hitherto been collected; and hence the author infers that it is impossible to decide upon the comparative age of all the formations in this basin until the species of the different deposits be separately ascertained,—a work which he hopes to see accomplished by M. Partsch.

The blue marls and sands are proved to be overlaid by a pebbly, calcareous conglomerate, which graduates upwards into the *Leitha-Kalk* or great, white, coralline building-stone of Vienna, containing bones of Tapir, Mastodon, &c. (Loretto, Margarethen, Eisenstadt, Wöllersdorf); and this rock is identified, by the author, with the coral limestone of Lower Styria, formerly described by Prof. Sedgwick, and himself.

It is stated that freshwater limestone, with Lymnæa, Helix, and Planorbis, is seen in patches (Eich Kogel, &c.), but that where this formation is absent, the *Leitha-Kalk* is usually succeeded by thick accumulations of gravel and sand, with concretions, and bones of Tapir, Mastodon, Anthracotherium, &c.; these gravel beds being of the

the same age with the superior deposits of Lower Styria, through which it has been asserted in a former memoir, that basaltic and trachytic eruptions have penetrated.

Lastly. The superficial covering of the low countries of Austria, called *Löss* *, is mentioned as being of great thickness and extent, containing bones of extinct species of elephants, mixed up with terrestrial shells of existing species, which character, combined with its loamy structure, is considered to indicate a tranquil period of deposit.

Recapitulating the principal points illustrated in this memoir, the author recurs to that essential part of it, in which, following up the idea of Prof. Sedgwick and himself, he endeavours to prove the large development and persistence in the eastern Alps of certain shelly deposits, of an age intermediate between the chalk and the tertiary formations; and he concludes by expressing an opinion, that with more extended examination, geologists may arrive at the conclusion, that the disturbing forces which in the West of Europe have destroyed the formations succeeding to the chalk, were local phænomena, which operated through a limited portion only of the earth's surface.

Feb. 16.—A letter was first read from Peter Cunningham, Esq. dated Newcastle on Hunter's River, New South Wales, Oct. 16, 1829; and communicated by John Barrow, Esq. F.R.S. &c.

This letter is written with a view to give some insight into the former state of the interior of New South Wales, and the writer accompanies it with a few organic remains; amongst others, with the second cervical vertebræ of a large animal found, on the surface. He states, that a great ridge separates the eastern and western waters, running from N.N.E. to S.S.W. and that in Liverpool plains the oldest rock appeared to be a hard, blue granite with red sandstone on its flanks. Granite has also been seen at the Wallanbai rivulet, at Carrington, and at Waybong,—distances of 35, 55, and even 100 miles from the sea. In the Liverpool range, it is said, there is a slaty, blue rock resembling grauwacké, and that this is succeeded, about 26 miles up the Patterson, by a coarse, red sandstone, and that again by a blue limestone. Another limestone is described as having an oolitic structure with corals on its surface. Most of the alluvial tracts in this part of the colony (Liverpool plains, &c.) are spoken of as consisting of rich, black, loose mould, formed by depositions from the hills, which on the slopes arrays itself into ridges, and in the plains into alternate hillocks and cavities.

Much red sandstone with salt springs is stated to exist in the interior, as well as on the coast of the colony, and the red, loose, sandy soil is said to be generally covered with the "iron tree", and with long, weak spikes of flaccid grass. It is to the want of an admixture of clay, or any retentive stratum, with the sands, that the author attributes the great deficiency of water in the colony, boring having been found quite useless throughout the absorbent sandstone country, although in the immediate flanks of the primary ridges water gushes

* See former Memoir, Phil. Mag. & Annals, N.S. vol. vii., p. 49.

 out

out freely, and chalybeate and saline springs occur at short distances from each other.

The coal of the colony appears to be a lignite, and is associated with grey marlstone containing impressions of leaves of dicotyledonous plants. The secondary rocks contain casts of Terebratulæ and other shells; but the author does not attempt to make out precisely the order of superposition, or the equivalents of the strata.

A memoir was then read "On the Geology of the Island of Juan Fernandez, in the Pacific Ocean, by Alex. Caldcleugh, Esq. F.G.S."

After a sketch of the past history and present state of this island, celebrated as the place of exile of Alexander Selkirk and the scene of the fabulous adventures of Robinson Crusoe*, the author proceeds to state that it is about twelve miles in length and four in breadth, possessing three ports, and consisting of very high land, the culminating point of which rises to about 3005 feet above the sea.

The author could discover no trace of a volcano said to exist here by former visitors; all the rocks, according to him, consist of basaltic greenstone and trap of various mineralogical structure, both amorphous and vesicular, together with trappean concretions, no other contained minerals being observable except olivine and metastique [?]. It is further mentioned that the basalt in parts is almost columnar, and in others has a peaked and serrated outline, the mass being, here and there, traversed by dykes.

Owing to the peculiar character of this basalt, and especially from the great quantity of olivine, the author compares its age with that of Bohemia, the Rhine, the Vivarrais, and Beaulieu in Provence.

ASTRONOMICAL SOCIETY.

Dec. 10, 1830.—The following communications were read:—

I. On a Method of determining the Declinations of Stars with one Mural Circle, by J. Pond, Esq. A.R.

II. A Letter from Capt. Philip P. King, R.N. on a Comet seen near the South Pole. "This comet was discovered by Lieut. Wickham, of H.M.S. *Adventure*, on the night of the 18th of last March. An imaginary line from γ Crucis through α Crucis to the smaller nebula, being crossed by another from Sirius through the larger nebula, their intersection would be very close to the comet's position. It was very bright and large. At midnight the following angular distances were measured with a sextant.

Comet and α Crucis	31° 50′ 30″
———— Sirius	71 0 0"

Three weeks after, when Captain King had arrived at the Strait of Magalhanes, the comet was too faint to be observed: it was seen near θ, ν, δ Junonis Pavo.

* There appears to be some confusion in this statement, arising probably from the prevailing, though, we believe, erroneous supposition, that the fiction of Robinson Crusoe was founded on the real adventures of Alexander Selkirk in Juan Fernandez. The scene of the adventures of Robinson Crusoe, as is evident from the particulars related in the narrative, is an island supposed to be situated on the north-eastern coast of South America, opposite the mouth of the river Amazons.—Edit.

A notice

A notice of the same comet, from Sir Alexander Johnstone, was communicated by Mr. Baily. It was discovered by Prof. Dabadie, at the Mauritius, on the evening of the 16th of March. It was first seen between the Chameleon and the great nebula. The next day it had advanced about 5° towards the north, and it continued in this direction with a diminished velocity, till it reached the eastern wing of Cygnus, where it disappeared about the end of May. The length of its tail never exceeded 5°. Professor Dabadie had no observatory; but he made a great number of observations of its distance from several stars, and from three of these he deduced the following elements.

Longitude of ascending node	=	228° 31′
Inclination of the orbit	=	49 46
Place of the perihelion	=	238 13
Perihelion distance	=	0·897
Passage of the perihelion, April 11, at 21^h		
Motion direct.		

The distances from which these elements are deduced are as follows:—

1830.	True time at Port Louis.					
March 19 at	8^h	45^m	50^s	Comet and Canopus	=	36° 11′
	9	2	0	Comet and α Centauri	=	34 50
April 1	16	48	0	Comet and α Centauri	=	69 34
	17	21	0	Comet and α Aquilæ	=	43 50
April 15	16	25	50	Comet and α Aquilæ	=	21 50
		40	50	Comet and α Centauri	=	97 39½

III. A letter from Sir Thomas Brisbane, with occultations of fixed stars by the moon, observed at Makerstown, lat. 55° 34′ 45″ N. long. 0^h 10^m 4^s W.

IV. An Account of a private Observatory, recently erected at Bedford, by Capt. W. H. Smyth, R.N.

Capt. Smyth gives sixty observations of standard stars, for each of which the zenith point was determined by the collimator, and deduces from the mean of the whole,

The latitude of the Bedford observatory	52° 8′ 25″·45
By eight observations of Polaris, above and below pole, face east and face west, instrument adjusted by the plumb-line and levels	52 8 29 ·71
Mean	52 8 27 ·58N

From six observations of the moon and moon-culminating stars, half of the first and half of the second limb, and compared with corresponding Greenwich observations,

The longitude of the Bedford observatory	$=1^m$ 51^s·975 West.
From four *corresponding* occultations . . .	1 51 ·486
From thirty-eight *non-corresponding* occultations and eclipses of Jupiter's satellites	1 47 ·948

Capt. Smyth is inclined to adopt, for the present, 1^m 51^s·7.

ZOOLOGI-

ZOOLOGICAL SOCIETY.

January 25, 1831. Sir Thomas Phillipps, Bart. in the Chair.

A specimen of the *Cereopsis Novæ Hollandiæ*, Lath., which had recently died at the Society's Menagerie in the Regent's Park, was exhibited.—Mr. Yarrell stated that having examined the body of the bird, he had remarked that its trunk was much shorter than that of the true *Geese*, and more triangular in its shape: the pectoral muscles were large and dark coloured. The *trachea* was of large, but nearly uniform, calibre, without convolution, and attached in its descent to the right side of the neck as in the *Heron* and *Bittern*; in the form of its bone of divarication and *bronchiæ* it most resembled the same part in the *Geese*. The muscles of voice were two pairs; one pair attached to the shafts of the *os furcatorium*, the other to the inner lateral surface of the *sternum*. The lobes of the liver were of large size, morbidly dark in colour; their substance broke down under the finger on the slightest pressure. The stomach, a true gizzard, was of small size as compared with the bulk of the bird. The first duplicature of intestine was six inches in length, at the returning portion of which the biliary and pancreatic ducts entered; from thence to the origin of the *cæca* four feet six inches; the *cæca* nine inches each; the *colon* and *rectum* together five inches: the whole length of the intestines was seven feet five inches. The stomach and intestinal *viscera* were loaded with fat; the other parts exhibited nothing remarkable.

Internally this bird, which was a male, resembled the true *Geese*; but externally, in the character of the bones, particularly in the rounded form of the edge, and great depth, of the keel of the *sternum*, and the lateral situation of the *trachea* in reference to the cervical *vertebræ*, it was decidedly similar to the *Ardeidæ*.

Mr. Yarrell availed himself of the occasion to remark that the *Natatores* of Mr. Vigors's systematic arrangement in Ornithology were placed between the *Grallatores* or *Waders* on the one side, and the *Raptores* or *Birds of Prey* on the other: and that the order contained five groups, two of which, the *Alcadæ* and *Colymbidæ*, were called normal, containing those birds which were considered to be the types of the true *Swimmers*, and three groups, *Anatidæ*, *Pelecanidæ*, and *Laridæ*, called aberrant, as deviating from the type, and exhibiting some characters which connected them either with the *Grallatores* or the *Raptores*. Some of the *Laridæ* and *Pelecanidæ* in the length of their wings, their consequent power of flight, and the mode of taking their food in the air, exhibited their obvious affinity to the *Birds of Prey* on the one hand; while some of the *Anatidæ*, by their lengthened legs and neck, and their habit of passing much of their time on land or frequenting shallow pools of water, showed an equal affinity to some of the *Waders*. This was the case with the *Cereopsis*, and occurred also in the *Semipalmated Goose* and in another *Goose* now living in the Society's Gardens, the *Anser jubatus*, Spix.

It was stated that in proportion as these birds departed from the characters of the true *Geese* in their external appearance and habits,
and

and in both approached to the *Ardeidæ*, they would also be found on examination to resemble them in their internal organization. In proof of this an extensive series of parts of the skeletons of birds from the true *Divers* to the *Cranes* was exhibited, and the peculiarities pointed out. The keel of the breast-bone in the *Ducks* and true *Geese* was shown to be of considerable depth, with its inferior edge nearly straight; those of the *Semipalmated Goose* and *Cereopsis* were shown to be much deeper in the keel, and the inferior edges much more convex; and comparison with the same parts from the *Spoonbill, Herons, Bitterns*, and *Storks*, showed the approximation to the *Ardeidæ* in form. The peculiarities of the whole series indicated, between the two extreme points, the developement of the powers of flight as contrasted with the maximum of the powers of diving, in a succession of characters as easily recognisable in the skeletons as in the external appearances of the birds themselves, and supplied a valuable auxiliary chain of affinities to assist the naturalist in his views of arrangement.

On the subject of the *Cereopsis* Mr. Bennett observed, that having lately had occasion to investigate the history of that bird, he had met with some facts respecting it which might not be without interest. After noticing the mistakes in Dr. Latham's original description and figure, which have been already corrected by MM. Temminck and Vieillot, he pointed out certain errors in those given by the two last-named writers, as compared with the bird on the table, and with seven living specimens in the Society's Collection, all of which, he believed, had been hatched in this country. Thus in the description of the latter author it is said, "la tête est couverte d'une peau nue, ridée et jaune, depuis la base du bec jusqu'audelà des yeux"; and in that of the former, "une peau ridée et jaunâtre couvre le front"; but this supposed naked skin does not exist in nature, and although represented in M. Vieillot's figure, is very properly omitted in that of M. Temminck. The latter indeed is, with the exception of the legs being coloured of a dingy yellow instead of a deep orange, a very characteristic representation. No synonyms had hitherto been added to the original name; but Mr. Bennett stated that he had little doubt, both from the description and locality, that a bird mentioned by Labillardière as seen at Esperance Bay, on the south coast of New Holland, and named by M. Vieillot, in the "Nouveau Dictionnaire d'Histoire Naturelle," *Le Cygne cendré*, was of the same species. To this bird it would appear, from d'Entrecasteaux's Narrative, that the unfortunate Riche had applied in his MSS. the name of *Anas Terræ Leeuwin*. On a specimen, in all probability not distinct, brought home by Labillardière, M. Vieillot founded a new species of Goose, *Anser griseus*, described at length in the second edition of the "Nouv. Dict. d'Hist. Nat." If this assumption be correct, the same individual must have afterwards served as the type of his figure of the *Cereopsis*; for only a single specimen of that bird existed until very lately (or indeed probably still exists) in the gallery of the Paris Museum, in which Labillardière's specimen was deposited.

A speci-

A specimen was exhibited of a small species of *Deer* from Chili, which had lived in the Society's Menagerie for upwards of twelve months, and which Mr. Bennett stated that he believed to be new. It is a female, and consequently does not offer the accessory characters which zoologists have been in the habit of deriving from the horns. The other distinctive marks are as follows:

Cervus humilis. *Cerv. parvus, obesus, brevipes; facie latâ, brevi, obtusâ; fissurâ infra-orbitali mediocri; caudâ subnullâ: corpore toto rufo, anticè nigrescenti, posticè fronte pedibusque inferioribus saturatioribus, infrà dilutiori.*

Alt. ad humeros vix $1\frac{1}{2}$ ped.: long. caudæ vix unciam superans.

Mr. Bennett added that he was informed by Captain P. P. King, R.N., that a second skin of the same species had been brought to England by him; that the young was spotted with yellow, and had a yellow stripe on each side of the back; and that the animal was plentiful at Concepçion, and found even as far south as the Archipelago of Chiloe, living, he believed, in small herds.

A hybrid *Pheasant* belonging to the Society having lately died at the Garden, Mr. Yarrell observed that he had examined its body, a preparation of a part of which, together with the preserved skin, was then on the table. He remarked that in mules produced between animals placed at different degrees of distance from each other in the scale of Nature, it was a point of some interest to ascertain the relative state of the sexual organs, which it might be expected would be found more or less perfect, depending on the extent of the distance interposed between the parent animals. The bird in question was a male, bred between the *pheasant* and the *common fowl*, but most allied in appearance to the former. The sexual organs appeared to be perfect and of large size for the period of the year.

Three examples of the *Ardea Nycticorax*, Linn., were placed on the table. On these Mr. Yarrell observed that the Menagerie of the Society had furnished an interesting link in this species, in a young bird which united in its plumage the brown spotted wing of the *Gardenian Heron* with the black head and ash-coloured back of the *Night Heron*: thus exhibiting the change from the young to the adult bird, and proving that the two supposed species are really but one.

Two living specimens were exhibited of the *Suricate, Ryzæna tetradactyla*, Illig., which had recently been added to the Society's Collection. Both individuals were extremely gentle, and suffered themselves to be handled and played with, without evincing any uneasiness.

At the request of the Chairman, Mr. Martin reported the morbid appearances observed in the *Lion* which recently died at the Society's Gardens. Before removing the skin, the whole of the body presented a remarkably bloated appearance, which was found on examination to be owing to general *emphysema*. This was suspected by Mr. Martin to be the result of morbid arterial secretion; it could not have been caused by putrefaction, the animal having been dead but

a few

a few hours, and the body being still warm. The same appearance had been not unfrequently observed by Mr. Spooner, the Veterinary Surgeon of the establishment, in animals worn out by lingering chronic disease. On examining the lungs, their cellular structure was found completely obliterated, except in one small portion, where alone any oxygenation of the blood could have taken place. They presented a dark appearance on the surface, with a hardness or density of structure which must have resulted from long-continued inflammation. They were also studded with tubercles. On cutting into them, purulent matter oozed from the incision, and several abscesses, though not large, were discovered. The liver was dark, and so soft as to break down with the slightest touch. The spleen presented no decided trace of disease. The intestines adjacent to the liver were tinged with a dark and somewhat purplish hue; but although distended with air presented nothing remarkable. The stomach contained only a little bile and *mucus.*

The muscles generally were pale and flabby, as might have been anticipated, where a chronic disease had wasted the vital energies, and where the blood, impeded in its passage through the lungs, had long ceased to be sufficiently oxygenated.

Mr. Owen commenced the reading of his account of the Myology of the *Simia Satyrus*, L. He confined himself to the notice of such muscles as are peculiar to that animal, and have not any analogues in the human frame; of those which, if analogous, deviate remarkably in their proportions and attachments; and lastly, of such as have been considered as of doubtful existence in the *Orang.*

The *occipito-frontalis*, which escaped the observation of Tyson and Dr. Traill (Wernerian Trans. iii.) in the *Chimpanzee,* and which some physiologists have asserted to be peculiar to man, is distinctly developed in the *Orang Utan.* Portions of this muscle were also found on the head of a *Chimpanzee* that had been flayed with great care, the rest having been removed with the scalp, to which the tendinous part closely adheres.

The following muscles of the face were described, *corrugator supercilii*, *levator labii superioris alæque nasi*, *levator anguli oris*, *zygomaticus major*, *depressor anguli oris*, *orbicularis palpebrarum* and *orbicularis oris.* On reflecting the inner membrane of the lips, the *depressores labii superioris* and *levatores labii inferioris* were found of considerable breadth and strongly developed: their action in protruding the lips in a conical form has been frequently noticed by those who have had opportunities of observing the living animal.

The *platysma myoides* is of greater extent than in the human subject, and some of the fibres have a different direction, bearing a greater resemblance to the cervical portion of the *panniculus carnosus* in some quadrupeds, as the *Beaver* and *Guinea-pig.*

The muscles of mastication, and the articulation of the lower jaw were described.

The *digastricus* has not any connection with the *os hyoides,* the anterior fleshy portion being altogether wanting in the *Orang Utan.* It is inserted by a strong round tendon into the angle of the lower jaw.

jaw. This circumstance is interesting in connection with the memorable dispute between Dr. Monro (primus) and the French anatomists, concerning the actions of this muscle; and it is remarkable that Winslow, with his accustomed ingenuity, should have alluded to such a disposition, in illustrating his opinions of the actions of the *digastricus* on the lower jaw in the human subject. Some peculiarities in the *mylo-hyoideus, genio-hyoideus,* and *omo-hyoideus* were noticed.

The peculiar muscle discovered by Tyson in the *Chimpanzee,* and called by him *levator claviculæ,* arises in the *Orang Utan* from the *occiput* and transverse process of the *atlas.* In the *Chimpanzee* which Mr. Owen dissected, he also found it arising from the transverse process of the *atlas,* and not from the second or third cervical *vertebra.* It is inserted broadly into the humeral extremity of the clavicle.

Neither in the *Orang Utan* nor in the *Chimpanzee* is there any true *ligamentum nuchæ.* The part commonly so called in the human subject, consisting also in these animals only of the inelastic commissural tendons of the *trapezii,* the *rhomboidei* and the *serrati postici superiores.* To give additional support, however, to the head of the *Orang Utan,* which preponderates so far anterior to the occipital *foramen,* the origins of the *rhomboidei* are extended upwards to the occipital bone, to which they broadly adhere, beneath the *trapezii.* In the *Chimpanzee* this disposition does not occur, but in both animals the *rhomboideus* is a single muscle, without division into a greater and lesser portion.

Three muscles supply the place of the *pectoralis major* in the *Orang Utan.* Their proportions and attachments were minutely described; and while speaking of these with reference to each other, it was found convenient to apply to them the names of *sterno-humeralis, costo-humeralis,* and *sterno-costo-humeralis.*

The reading of the remainder of this part of the anatomy of the *Orang Utan* was postponed to a future meeting of the Committee.

Several species of *Birds* belonging to the collection recently made by Capt. Philip P. King, R.N., during his survey of the Straits of Magellan, were exhibited. Other birds from the same collection had been named and characterized at the Meeting on the 14th of December: and on the present occasion Capt. King pointed out the distinctive characters of the following species which he believed to be new.

Synallaxis anthoïdes. *Syn. supra brunnea, plumis in medio fusco latè striatis, tectricibus alarum superioribus rufo tinctis; subtus pallidè cinerea; rectricibus lateralibus ad marginem externum, fasciâque alarum, rufis.*

Statura *Syn. Spinicaudæ.*

Dendrocolaptes albo-gularis. *Dend. corpore supra abdominisque lateribus rufo-brunneis; remigibus secundariis, dorso imo, caudâque rufis; mandibulâ inferiori ad basin, gulâ, jugulo, pectore, abdomineque medio albis, hujus plumis brunneo ad apicem marginatis; rostro sursum recurvo.*

Longitudo circiter $7\frac{1}{4}$ uncias.

Trochi-

TROCHILUS FERNANDENSIS. *Troch. ferrugineo-rufus; capitis vertice splendenti-coccineo; remigibus fuscis.*

Longitudo 5 uncias.

Habitat in insulâ Juan Fernandez.

TROCHILUS STOKESII. *Troch. corpore supra viridi-splendente, subtus albo viridi-guttato; capite supra, guttisque confertis gulæ lazulino-splendentibus; remigibus fusco-atris; remigum omnium, mediis exceptis, pogoniis internis albis.*

Longitudo 4½ uncias.

Habitat in insulâ Juan Fernandez.

PHALACROCORAX IMPERIALIS. *Phal. capite cristato, collo posteriori, corporeque supra intensè purpureis; alis scapularibusque viridi-atris; remigibus rectricibusque duodecim fusco-atris; corpore subtus, fasciâ alarum, maculâque dorsi medii sericeo-albis; rostro nigro; pedibus flavescentibus.*

Statura *Phal. Carbonis.*

Habitat in sinubus interioribus oræ occidentalis.

PHALACROCORAX SARMIENTONUS. *Phal. capite, collo, dorsoque imo atro-purpureis; pectore abdomineque albis; dorso superiori, scapularibus, alisque viridi-atris; remigibus rectricibusque duodecim atris; gulâ, genis, femorumque tectricibus superioribus albo-notatis; rostro nigro; pedibus flavescentibus.*

Statura præcedentis.

Habitat in Freto Magellanico.

PHALACROCORAX ERYTHROPS. *Phal. capite, collo, corporeque supra purpureo-atris; pectore abdomineque albis; genis parcè albo-notatis; facie nudâ rubrâ; remigibus, rectricibus duodecim, rostroque sub-brevi atris: pedibus flavescentibus.*

Staturâ paulo minor præcedentibus duobus.

February 8, 1831.—N. A. Vigors, Esq. in the Chair.

It was announced that the Council had Resolved, "That the Meetings of the Committee are open to every Member of the Society." In this resolution the Committee cordially concurred; and also in the propriety of distributing cards of the Meetings to the Members of the Society residing in or near London.

The skeleton and parts of the *viscera* of one of the Society's specimens of the *Chinchilla*, (*Chinchilla lanigera*,) were exhibited, and the following notes by Mr. Yarrell were read.

"On the death of one of the specimens of this interesting little animal in the collection of the Zoological Society, the Museum, previously containing a preserved skin, was enriched with a skeleton and preparations of parts of the *viscera*. Of these additions I have been permitted to furnish a description, which I was the more desirous to do, as no notice of the internal parts of this animal has appeared, that I am aware of, except as far as regards its dentition; and on this part of the subject I was anxious to correct an error I had committed in a short notice published in the fourth volume of the 'Zoological Journal,' page 317, from the prescribed use of limited materials.

 "It

"It may be necessary to state that at the time of examination all the *viscera* had been preserved some months in a weak solution of spirit.

"The lungs are composed of three small lobes on each side. The heart is flattened in form from behind forwards, measuring $\frac{6}{10}$ths of an inch across its base, and but $\frac{4}{10}$ths in depth; the want of *apex* gives it a rounded and muscular appearance. The liver exhibits two large and equally-sized lobes, and two smaller lobes. The stomach, a single cavity, measures from the entrance of the *œsophagus* round the great curve to the pyloric contraction 5 inches $\frac{8}{10}$ths, the greatest breadth 2 inches $\frac{2}{10}$ths, the depth 1 inch $\frac{4}{10}$ths; the spleen is small and elongated. The length of the small intestines from the *pylorus* to the end of the *ilium* 3 feet 10 inches; the *cæcum* and first portion of the *colon* are of large size, made up of three half-circular convolutions, one central, with one of smaller dimensions on each outer side, containing numerous cells and divisions, strengthened by muscular bands and *septa;* the whole length of *cæcum, colon* and *rectum*, measures 4 feet 10 inches. With the exception of the *cæcum* and commencement of the *colon*, which as I have stated are voluminous, all the intestines are of very small calibre. The kidneys vary somewhat in shape; one measures $\frac{5}{10}$ths of an inch in length and $\frac{3}{10}$ths in breadth, that on the opposite side is much more spherical. The specimen is a female, and the uterine *cornua* measure each $3\frac{1}{2}$ inches in length.

"Of the skeleton, when mounted, the whole length from the nose to the end of the tail is 13 inches $\frac{6}{10}$ths; the upper surface of the *cranium* from the *occiput* to the inter-orbital space is in form triangular and flat, the width at the *occiput* 1 inch $\frac{1}{10}$th, of the inter-orbital space $\frac{4}{10}$ths, the whole length of the head 2 inches $\frac{2}{10}$ths, the mastoid processes and auditory cells of very large size, the external *meatus* also large, oval, directed upwards and backwards; the *zygoma* narrow and slender posteriorly, but deep and stronger at its junction with the malar bone, which has an ascending bony division between the orbits and temporal *fossæ;* the nasal bones narrow, convex, and of parallel diameter; the lower jaw is curved, broad and strong, the course of the *incisor* teeth is visible, and the alveolar cavities of the molar teeth are well defined externally; the coronoid processes are wanting, apparently as if broken off during the preparation of the skeleton, but have obviously been of very small size; the condyle elongated from before backwards, the plate deep, and the posterior angle of considerable length. Dentition $\frac{2}{2}\frac{-}{-}\frac{8}{8}$: the exposed portion of the *incisors* measures $\frac{4}{10}$ths of an inch in length; the molar teeth are all made up of three parallel portions or bony *laminæ*, each portion invested with a thin coat of enamel and closely united, the base of a molar tooth presenting six lines of enamel and three cavities; the anterior third of the first molar tooth on each side, above and below, is smaller than the other two portions, and gives to these teeth a triangular-shaped crown; the posterior third portion of the last molar tooth on each side above is nearly round, and gives an increase of surface to these also;

also; in the molar teeth of the lower jaw the fold of enamel between the first and second portions of the bony *laminæ* of each tooth does not reach quite to the outer edge, and the two portions of bone appear therefore to be only partially separated. The direction of the parallel *laminæ* of all the molar teeth is not at right angles with the line of the maxillary bones, but inclining obliquely from without backwards.

"The length from the *atlas* to the end of the tail is 11 inches $\frac{4}{10}$ths; cervical *vertebræ* 7, dorsal 13, lumbar 6, sacral 2, and caudal 23. The *scapulæ* are small, measuring 1 inch from the external angle to the articulation with the *humerus*, the spine is but little elevated, the *acromion* ample, the clavicles perfect; length of the *humerus* 1 inch $\frac{2}{10}$ths, the bone strong and furnished with an elongated crest descending from the head; from the *olecranon* to the carpal articulation 1 inch $\frac{6}{10}$ths, the *ulna* and *radius* firmly anchylosed throughout the distal half of their length; thence to the end of the longest of the five toes $\frac{8}{10}$ths of an inch. The ribs 13 pairs. The bones of the *pelvis* slender and elongated; from the crest of the *ilium*, which is but little produced, to the inferior edge of the *ischium* is 1 inch $\frac{9}{10}$ths; the *ossa pubis*, slight in structure, advancing but little, the *symphysis* elongated, and the *obturator foramen* of large size. The *femur* is straight, strong and smooth, and measures 1 inch $\frac{8}{10}$ths; the *tibia* 2 inches $\frac{2}{10}$ths; the *fibula* is complete and forms the external *malleolus*; from the *os calcis* to the end of the longest toe 2 inches $\frac{1}{10}$th; the toes four in number, of which the outer one is the shortest, the third from the outside the longest, the second and fourth equal.

"In the published observations before referred to I stated that the *Chinchilla* appeared to be closely allied to Mr. Brookes's new genus *Lagostomus*, and the character of the skeleton of the *Chinchilla* compared with the figure and description of *Lagostomus* in the 1st part of the 16th volume of the 'Transactions of the Linnean Society' confirms the general similarity. Still, the more complicated structure of the teeth, and the existence of an additional toe on each of the feet, require for the *Chinchilla* the generic distinction claimed for it by Mr. Bennett and by Mr. Gray.

"The resemblance of the skeleton of the *Chinchilla* to that of the *Jerboa* is also remarkable, particularly in the form of the head, in the excessive development of the auditory cavities, and the small size of the anterior extremities compared with the hind legs."

Mr. Yarrell having concluded the reading of his Notes, it was remarked that MM. Isidore Geoffroy-Saint-Hilaire and Dessalines d'Orbigny had proposed, in the 'Annales des Sciences Naturelles' for November 1830, the creation of a new genus, *Callomys*, to include the *Chinchilla* and the *Viscaccia*. The latter animal is the *Dipus maximus*, De Bl., and consequently the type of the genus *Lagostomus*, described by Mr. Brookes in a paper read before the Linnean Society in 1828, and published in the Transactions of that body in 1829, in which the system of dentition and the osteology are treated of in detail. The *Chinchilla*, long known in commerce but

but only recently made known to science, was described as the type of a distinct genus, under its common name, by Mr. Bennett in 1829, and by Mr. Gray in August 1830: its true characters seem even now to be unknown to the French authors above referred to, who appear to be acquainted with its skin alone, and never to have examined either its teeth or the number of its toes. In these respects it deviates from the characters of their proposed genus; a genus which cannot be adopted, inasmuch as it is composed of heterogeneous materials, and as the two types included in it have both previously been described and designated as distinct groups.

Specimens were exhibited of the *tracheæ* of various *Gallinaceous Birds* included in the genera *Pauxi*, *Crax* and *Penelope* of M. Temminck; and Mr. Yarrell observed that these birds have each, as far as they have yet been examined, been found to possess a specific difference in their organs of voice. Among the *tracheæ* placed on the table was that of the *Red-knobbed Curassow*, *Crax Yarrellii*, Benn., a new species lately described from the Society's Menagerie, and which had recently died. The *trachea* of this species differs from all those previously known, but most resembles that of the *Crax Alector*, L.; while in external characters the bird approaches the *Crax globicera*, L., from which it is distinguished by the redness of its cere and by a prominence on each side under the base of the lower jaw, in addition to the globose knob near the base of the upper. The tube in the *Crax Yarrellii* is straight throughout its whole length, except a short convolution imbedded in cellular membrane placed between the shafts of the *os furcatorium*. The *trachea* is narrow, and the fold, invested and supported by a membranous sheath, gives off one pair of muscles, which are inserted externally below the *apex* of the *os furcatorium*. The lower portion of the tube, immediately above the bone of divarication, sends off a pair of muscles to be inserted upon the *sternum*. The upper pair of muscles (furculo-tracheal) influence the length of the tube above the convolution. The inferior pair (sterno-tracheal) have the same power over the bronchial tubes and that portion of the *trachea* which is below the convolution.

Several specimens were laid on the table of a *Clupea* taken in the mouth of the Thames, which Mr. Yarrell regarded as distinct from the *common Herring* of our coasts, the *Clupea Harengus*, Linn. He dedicated it to Dr. Leach, who, he was informed, has often stated that the British coast possessed a second species of *Herring*. The *Clupea Leachii* is much deeper in proportion than the *common Herring*, an adult fish 8 inches long being 1 inch $\frac{7}{8}$ths deep, while a *common Herring* of the same depth measures $10\frac{1}{2}$ inches in length. The dorsal and abdominal lines of the new species are much more convex; the latter is keeled, but has no serration. The under jaw has three or four prominent teeth placed just within the angle formed by the *symphysis*: the upper *maxillæ* have their edges slightly crenated. The eye is large. The scales are smaller than in the other species, and there is no distinct lateral line. The back and sides are deep blue with green reflections, passing into silvery white beneath.

neath. The dorsal fin is placed behind the centre of gravity; but not so far behind it as in the *common Herring*. The number of the fin-rays and of the *vertebræ* differ in the two species as follows:

	D.	P.	V.	A.	C.	*Vertebræ.*
Clup. Harengus	17 ..	14 ..	9 ..	14 ..	20	56
Clup. Leachii	18 ..	17 ..	9 ..	16 ..	20	54

The new species differs also from the *common Herring* in flavour, being much more mild. It is now full of roe, while the adult *common Herrings* ceased spawning in November, and having retired subsequently to the deep waters are not at present to be met with on the southern coast. Mr. Yarrell added, that there was reason to believe that a third species of *Herring*, of a larger size than either of the others, occurred sometimes on our eastern coast. He also mentioned that he had obtained last summer from the Thames, the two *Shads* regarded by M. Cuvier as the *Clupea Alosa*, Linn., and the *Clupea fallax*, LaCép.

Mr. Yarrell stated that he had received a letter from Mr. Dillwyn, mentioning the capture in Swansea Bay of a specimen of the *Labrus maculatus*, Bloch; being a second instance of the occurrence of this fish on the British coasts within a few weeks.

Mr. Yarrell also stated that the *Summer Duck*, *Anas sponsa*, Linn., male and female, had been shot recently near Dorking. The *Anas occidua* had also occurred in this country: and another American and Northern species of bird, the *Alauda alpestris*, Linn.

The Chairman resumed the subject of the Himalayan birds, and exhibited and described the following species.

Phœnicura cæruleocephala. *Phœn. atra, abdomine strigâque alarum longitudinali albis; capite pallidè cæruleo.*

Statura *Phœn. communis.*

Phœnicura leucocephala. *Phœn. corpore apiceque caudæ atris; abdomine, crisso, uropygio, caudâque rufis; capite supra albo.*

Statura *Phœn. rubeculæ.*

Phœnicura rubeculoïdes. *Phœn. capite, collo, corporeque supra atro-cœruleis, capitis summo splendidiore; abdomine albo; pectore rufo.*

Statura *Phœn. cœruleocephalæ.*

Phœnicura fuliginosa. *Phœn. corpore fuliginoso-plumbeo; caudâ rufâ.*

Staturâ paullo major quam præcedens.

Emberiza cristata. Mas. *Emb. capite cristato corporeque atris; alis caudâque rufis.*

Fœm., aut Mas jun.? *Capite subcristato corporeque fuscis, abdomine imo pallidiori; alis caudâque rufescentibus, fusco tinctis.*

Statura *Carduelis communis.*

Lamprotornis spilopterus. Mas. *Lamp. supra plumbeo-canus, plumis ad apicem fusco marginatis; subtus albus, rufo tinctus; uropygio rufescenti; remigibus atris viridi splendentibus, maculâ albâ; caudâ brunneâ; gulâ intensè rufâ.*

Fœm. *Supra pallidè brunnea, subtus albescens, brunneo tincta.*

Statura *Lamp. cantoris.*

Myo-

Myophonus Horsfieldii. *Myoph. cœrulescenti-ater, fronte, humeris, marginibusque plumarum pectoris splendidè cœruleis.*

Statura *Myoph. cyanei*, Horsf.

Phasianus Staceii. *Phas. stramineo-albus, supra frequenter, subtus parcè nigro fasciatus, dorso abdomineque imis rufescentibus; capite cristato fusco; caudâ fasciis latis nigris, ad basin internè rufis, ornatâ.*

Longitudo *corporis* ab apice rostri ad apicem caudæ, 3 pedes 4½ uncias.

Otis nigriceps. *Ot. corpore supra pallidè badio, rufo-brunneo graciliter undulato; collo, maculis parcis alarum, abdomineque albis; capite cristato, tectricibus alarum exterioribus, remigibus, notâque grandi pectorali nigris.*

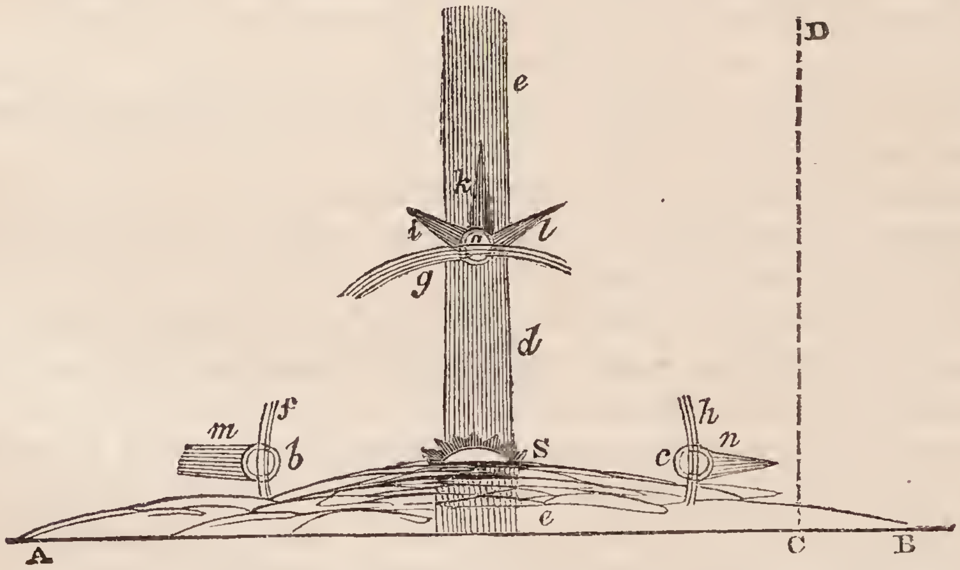
Longitudo *corporis* ab apice rostri ad apicem caudæ, pedes 4; altitudo, 4⅓.

The Chairman also directed the attention of the Committee to a remarkable deficiency observable in some of the groups of the *Psittacidæ*, viz. the absence of the *os furcatorium*. This deficiency he had observed in the osteology of the *Psittacus mitratus*, the *Platycercus eximius*, and the *Psittacula galgula*; skeletons of the two last of which species were exhibited. He observed that this extraordinary deficiency evinced the approaching affinity of that group of birds to the *Rasores*, one of the most conspicuous groups of which, the typical *Struthionidæ*, exhibited a like deficiency, indicating a corresponding failure in the powers of flight.

XL. *Intelligence and Miscellaneous Articles.*

PARHELIA, &c. LATELY SEEN AT BEDFORD.

The following remarkable phænomena presented themselves at Bedford on February 1st, 1831, at 4 p.m.



A B represents the western horizon, C D the prime vertical, S a segment of the sun's disk appearing above a dark cirrostratus cloud, and covered with thin vapour, which gave it the appearance of highly burnished

burnished gold; *a, b, c,* three parhelia all nearly of the apparent size of the sun; *d, e,* a column of white light meeting the horizon downwards, and indefinitely extended upwards; *f, g, h,* portions of a broken solar halo, exhibiting distinctly the prismatic colours; *i, k, l,* three luminous trains of light terminating in points, the train *k* being highly coloured with yellowish-red vapour, probably owing to its being situated in the centre of the column of light *d, e;* it was also much longer than the other two, *i* and *l,* which were very faintly tinged: the train *m* terminated very abruptly, but was more distinct than the train *n,* which terminated in a point.

These interesting phænomena were refracted upon dense attenuated cirrostratus vapour; but as it was rapidly moving out of the refracting angles of the sun's rays, they did not continue visible for more than twelve minutes.—W. H. WHITE, H.M.C.S.

AURORA BOREALIS OF THE 7TH OF JANUARY.

Gosport Observatory, Jan. 7th, 1831.

In the afternoon of this day there was a peculiar brightness in the atmosphere near the horizon, for several degrees on each side of the true north point, which indicated the approach of an aurora: indeed we have reason to suspect that it was a faint appearance of one, while the sun shone in all his splendour, without the interposition of cloud or vapour. Shortly after sunset an aurora borealis gradually rose above the northern horizon, and at a quarter past five o'clock it had assumed the form of an arch of refulgent light ten degrees high, and seventy degrees wide. From this time till half-past five it continued to increase in the intensity of its light, expanding to the western point of the horizon and 55 degrees to the eastward of north, which made the chord of the aurora 155 degrees. Now a bright flame-coloured rainbow-like arch, between three and four degrees broad, and pretty well defined at its upper edge, emanated from the curved edge of the aurora to an altitude of 35 degrees; and while it remained apparently stationary, a beautiful rainbow-like arch, still more brilliant, formed about ten degrees south of the zenith, by streamers suddenly springing up from the N.E. by E. and W. by S. points of the horizon and meeting in the zenith, so that these two bows presented themselves at the same time.

At thirty-five minutes past five the latter bow, in some parts four and in others six degrees wide, divided a little to the eastward of its vertex; and the long streamers which formed it passed off gently to the southward in very bright patches, two in the S.E. and one in the S.W. quarters, like luminous clouds, and continued in sight nearly a quarter of an hour. One of these bright patches nearly covered Orion several minutes.

At forty minutes past five another rainbow-like arch, equally wide and bright, was formed by long streamers from about the same points of the horizon, whose point of convergence was the same, and its course through the feet of Gemini, near the Pleiades, through Aries, the square of Pegasus, the head of Equuleus, and the bow of

Antinous

Antinous. It passed off gradually towards the south, and at a quarter before six the planet Mars, then near the meridian, and about 45 degrees in altitude, rested, as it were, conspicuously on it. At six it had gone far towards the southern horizon, and could scarcely be perceived, leaving the sky unusually clear and bright. By this time the bow over the aurora had much increased in altitude, and was nearly effaced.

At a few minutes past six, after a great many coloured columns of light had risen from the N.E. and N.W. quarters, and passed the zenith, the aurora sunk considerably towards the horizon; but its upper edge remained bright and very well defined. Some of the streamers or columns were long, others short, and the widest generally remained long enough to pass through a gradation of prismatic colours. At half-past six the aurora again increased in altitude, and vivid coruscations radiated from every part of its arch, and on intermixing with each other formed wide columns, which were so grand with crimson tints as to astonish every spectator. Between seven and eight the aurora had spread at least *two-thirds* over the heavens, and as far as the shoulders of Orion on the eastern side of the meridian, when large perpendicular columns, and short pointed luminous coruscations, rising from the aurora like glittering spears and conical points in nearly parallel rows, now mixing and then dividing, all passed through red, orange, lake, crimson, green, and purple tints, so that the appearance altogether over so great an extent of the heavens was awfully grand and sublime, particularly when contrasted with the cerulean sky, and its spangled constellations in the southern portion of the hemisphere.

At ten minutes before eight, when the aurora was in its greatest splendour, several thousand persons had assembled in groups in various parts of the town and neighbourhood, and where they could get an uninterrupted sight of Portsdown Hill, behind which the finest part of the aurora appeared.

At five minutes before eight another luminous rainbow-like arch stretched across the heavens from the eastern point of the horizon, and displayed several prismatic colours while passing southward. Soon after eight a large tenebrious space, in and near the horizon, presented itself several degrees on each side of the magnetic north, and the aurora still far over the heavens, gradually diminished. At nine it again ascended, and wide columns rose from every part of its arch, and passed through the same colours as before mentioned.

Between nine and ten the magnetic needle, which in the early part of the evening stood at 24 degrees West of the true North, was disturbed, and receded upwards of half a degree northward, either by the influence of the aurora, or by a change of wind from N.E. to S.W. and of course a change in its electrical state. At a quarter before eleven there was a grand display of about twelve or fourteen glowing columns from the aurora, several of which passed beyond the zenith, when a perfect red rainbow-like arch, ten degrees above the aurora, was visible. At eleven another bow $3\frac{1}{2}$ degrees wide rose from the aurora, and passed through Aries,

Cassiopeia,

Cassiopeia, Ursa Minor, and the square of Ursa Major: it soon reached the zenith and gradually disappeared.

At half-past eleven the aurora again began to sink slowly, and did not rise afterwards. At five minutes before twelve a large brilliant meteor, the only one observed through the night, passed under Ursa Major. At one o'clock A.M. the highest part of the aurora about the magnetic north had sunk to within six or seven degrees of the horizon; yet bright coruscations occasionally emanated from it till two, when the observations were discontinued, as no more interesting meteoric appearances were likely to occur.

The vertex of each of the rainbow-like arches that were formed by streamers from or near the intersecting points of the aurora with the horizon, coincided with the magnetic north within one or two degrees, and uniformly preserved this parallelism in passing off towards the south.

During the evening and night, while the aurora was pretty high, the light which it spread through the atmosphere was equal to the light of the moon shining through a very attenuated cloud; and the stars which formed the square and tail of Ursa Major were almost imperceptible, in consequence of the refulgence of the aurora.

Of all the auroræ boreales that have been observed here the last twenty years (some say forty years), this was the most extensive, the most beautiful in colours, and the most interesting, on account of the singular phænomena which it displayed, in the number of distinct luminous bows, which were presented in the course of the night. This aurora borealis was seen at Paris and at Brussels.

In two days and a half after the aurora a very strong gale of wind came on from the north-east, and continued about twenty-four hours.

There were also faint auroræ on the preceding and following evenings; and a luminous one, though not high, from six till nine in the evening of the 11th, which would have been interesting but for the interposition of clouds throughout the night.

A MODE OF ASCERTAINING THE VALUE OF MANGANESE ORES.

Dr. Turner, Professor of Chemistry in the London University, has given a method of ascertaining the commercial value of the ores of manganese, in the last Number of the Royal Institution Journal, the object being solely to ascertain the relative quantities of chlorine, which an equal weight of each ore was capable of supplying. The method of manipulating is as follows:—About ten grains of the ore in fine powder is introduced into a flask capable of containing about an ounce of water, and into its neck is fitted by grinding a bent tube about two inches long, which conducts the chlorine from the flask into a tube about sixteen inches in length, and five-eighths of an inch wide, full of water, and inverted in a small evaporating capsule, employed as a pneumatic trough. The apparatus being adjusted, the flask is half filled with concentrated muriatic acid, the conducting tube instantly inserted, and heat applied by means of a spirit-lamp. The air of the flask, together with the chlorine, is then collected, the greater part of the latter, if the gas is not very rapidly disengaged, being ab-

 sorbed

sorbed in its passage; and, consequently, the receiving tube, at the close of the process, will be about half full of gas. When the ore is completely dissolved, the last traces of the chlorine are expelled from the flask by muriatic acid gas. In order that the chlorine thus collected may be entirely absorbed, the aperture is closed by a ground stopper, or still more conveniently with the finger, and the gas is well agitated until the chlorine is wholly absorbed. As the solution in the inverted tube may become too saturated to dissolve all the chlorine, it is convenient to fill a pipette with pure water, and, with the aid of the mouth, force a current to ascend into the tube, and thereby cause the heavier solution to flow out into the capsule.

The absorption being complete, the solution of chlorine is introduced into a six- or eight-ounce stoppered bottle, and a dilute solution of green vitriol, made, for example, with a hundred grains of the crystallized salt and a pint of water, is added in successive small quantities until the odour of chlorine just ceases to be perceptible. The quantity of liquid required for the purpose may be conveniently measured in a tube about sixteen inches long, and three quarters of an inch in diameter, divided into two hundred parts of equal capacity, and supplied with a lip, so that a liquid may be poured from it without being spilled. In conducting this part of the process, the operator will perceive two odours:—at first, the characteristic odour of chlorine, accompanied with the peculiar irritation of that gas; and, subsequently, an agreeable, somewhat aromatic odour, unattended with the slightest irritation. The object is, to add exactly so much solution of iron as suffices to destroy the former of these odours, without attempting to remove the latter; a point which, with a little practice, may be readily attained. The whole of the iron is thus brought into the state of peroxide.

The first trial is generally accompanied with some loss of chlorine, and should only be used as a guide to a second and more precise experiment. Accordingly, a weighed portion of the same ore is dissolved, and the chlorine collected as before, except that the solution of green vitriol, in quantity rather less than sufficient, is at once introduced into the inverted tube and capsule. A more ready and perfect absorption of the chlorine is thus effected, and the subsequent addition of a small quantity of sulphate of iron suffices for completing the process.

The principal sources of error in this method are the two following:—loss of chlorine, by smelling repeatedly, and exposure to the air when the gas is absorbed by pure water; and oxidation by the air when the absorption is made directly by means of the solution of iron. The small flask and inverted tube are apt to retain the odour of chlorine, and should therefore be rinsed out with the absorbing liquid. It should be remembered, also, that a given quantity of chlorine will emit a more or less distinct odour, accordingly as it is more or less diluted. But by operating always in the same manner, and employing such weights of different ores, that equal quantities of the solution may contain nearly equal quantities of chlorine, it is easy to be independent of these errors of manipulation by causing them to affect each

each experiment to the same degree; it will accordingly be found, with a little practice, that results of surprising uniformity may be thus obtained; and even the constitution of pure oxides of manganese may be ascertained by this method, almost with the same accuracy as by directly determining the quantity of oxygen.

The substance first used by Dr. Turner to determine the quantity of chlorine was a solution of indigo; but a weak solution of green vitriol, employed by Mr. Dalton for ascertaining the strength of bleaching powder, was found to be more precise in its indications.

ELECTRO-CHEMICAL DECOMPOSITION OF THE VEGETO-ALKALINE SALTS.

Mr. Brande states that Sir H. Davy suggested the possibility that morphia, when electrified in contact with mercury, might afford results corresponding to those which Berzelius had observed in respect to ammonia, thinking that the nascent elements of the morphia, as liberated by electrical decomposition, might effect a similar apparent amalgam of mercury: he probably made a few experiments on the subject, which do not appear to have been recorded. Mr. Brande electrified moistened morphia and mercury, the metal being rendered first feebly, and afterwards more powerfully, negative. No change occurred in the fluidity of the metal, nor when mixed with water did it exhibit any appearance of having united to foreign metallic matter; cinchonia similarly treated exhibited similar results.

Quina, when moistened and electrified in contact with mercury on a disc of positive platina, presented different appearances: the metal became filmy, butyraceous, and had its fluidity diminished. When put into water, a peculiar motion was perceptible on its surface, small globules of gas were liberated, and it slowly regained its usual aspect. These appearances were eventually referred by Mr. Brande to the obstinate adhesion of a small quantity of lime to the quina, and of which he has not been able to deprive it.

The electro-chemical decomposition of the salts of the vegeto-alkalies is very characteristic, in consequence of the difficult solubility of their bases. When a solution of sulphate of morphia, cinchonia, or quina is decomposed between two plates of platina, the negative plate, if the solutions be strong, is soon covered with a white crust of the alkaline base, which gradually falls off in films; when the solution is more dilute, they fall in the form of a white cloud.

No appearances of metallization were obtained by electrifying mercury negatively in contact with the above-named salts. When infusions of opium, bark, and nux vomica were treated in this way, no distinct separation of their difficultly soluble alkaline matter occurred, as might have been expected, probably in consequence of the multiplicity of substances present.—*Royal Institution Journal,* Feb. 1831.

LUNAR

LUNAR OCCULTATIONS.

Occultations of Planets and fixed Stars by the Moon, in March 1831. *Computed for Greenwich, by* Thomas Henderson, *Esq.; and circulated by the Astronomical Society.*

1831.	Stars' Names.	Magnitude.	Ast. Soc. Cat. No.	Immersions.				Emersions.			
				Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.	Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.
				h m	h m	°	°	h m	h m	°	°
Mar. 1	65 Virginis	6	1531	8 27	9 51	116	79	9 12	10 36	200	166
	66 Virginis	6	1532	9 5	10 29	85	50	10 12	11 36	227	198
	l^2 Virginis	6	1545	14 36	15 59	35	49	15 42	17 5	277	301
5	*m* Scorpii	5	1907	13 41	14 49	72	46	15 1	16 8	256	242
24	18 Leonis	6	1177	7 37	7 31	345	319	☽ almost touching Star.—Occulted to places further North.			
28	k^4 Virginis	6	1500	8 10	7 48	40	3	9 9	8 47	274	241
31	γ Libræ	4·5	1764	14 50	14 15	102	96	16 2	15 27	222	228

METEOROLOGICAL OBSERVATIONS FOR JANUARY 1831.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·60. Jan. 7. Wind N.E.—Min. 29·08. Jan. 21. Wind S.E.
Range of the mercury 1·52.
Mean barometrical pressure for the month .... 29·823
Spaces described by the rising and falling of the mercury............ 6·500
Greatest variation in 24 hours 0·800.—Number of changes 18.
Therm. Max. 53°. Jan. 23. Wind E.—Min. 25°. Jan. 25. Wind N.
Range 28°.—Mean temp. of exter. air 38°·69. For 30 days with ☉ in ♑ 37·57
Max. var. in 24 hours 18°·00.—Mean temp. of spring-water at 8 A.M. 49·42

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the morning of the 17th... 99°
Greatest dryness of the atmosphere, in the afternoon of the 31st ... 62
Range of the index 37
Mean at 2 P.M. 78°·0.—Mean at 8 A.M. 83°·3.—Mean at 8 P.M. 82·0
—— of three observations each day at 8, 2, and 8 o'clock .... 81·1
Evaporation for the month 0·85 inch.
Rain in the pluviameter near the ground 2·30 inches.
Prevailing wind, E.

Summary of the Weather.

A clear sky, 3½; fine, with various modifications of clouds, 8; an overcast sky without rain, 13; foggy, ½; rain, sleet and snow, 6.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
11	7	27	0	9	7	31

Scale

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
4	$5\frac{1}{2}$	8	$5\frac{1}{2}$	$2\frac{1}{2}$	1	$\frac{1}{2}$	4	31

General Observations.—The first part of this month was dry, the latter part was wet and alternately mild and cold, with occasional gales of wind. After the aurora borealis in the evening of the 11th, the sky was hidden by clouds till the 24th, with the exception of about one day.

On the 23rd the thermometer in the shade rose to fifty-three degrees, and on the 26th only to thirty-four degrees: in the night of the 22nd it receded only to forty-six degrees, but in the night of the 25th, to twenty-five degrees, the minimum temperature for the month.

On the 25th and 26th there was a uniform elevation of the mercury in the barometer, but a very sudden depression of four-fifths of an inch on the 27th, with rain. On the 28th and 29th the mercury rose half an inch in the tube, and a little snow came on with an easterly wind. On the descent of the mercury on the 31st between three and four inches of snow fell here in the night, even with a strong gale from the south. In the neighbourhood of London upwards of two feet in depth of snow are said to have fallen upon a plane surface about the same time; and in places where it had drifted, the stage-coaches could not pass before it was cleared away, consequently they were several hours behind their usual time.

The atmospheric and meteoric phænomena that have come within our observations this month, are one lunar halo, four meteors, four auroræ boreales, and seven gales of wind, or days on which they have prevailed, namely, four from the North-east, one from the East, one from the South, and one from the South-west.

REMARKS.

London.— January 1, 2. Fine. 3, 4. Overcast. 5. Foggy. 6. Fine: clear and frosty at night. 7. Clear, with frost: dense fog at night. 8. Frosty. 9. Overcast. 10. Hazy, with small rain. 11. Cloudy and cold. 12, 13. Drizzly and foggy. 14. Hazy. 15, 16. Cold and damp. 17. Cloudy: slight rain at night. 18. Rain: lightning at night. 19—23. Wet. 24. Sleet: frosty at night. 25, 26. Clear and frosty. 27. Sleet. 28, 29. Fine. 30. Fine: foggy at night. 31. Frosty: fog in the morning, succeeded by a heavy fall of snow.

Penzance.—January 1. Fair: rain at night. 2. Rain: fair. 3. 4. Fair. 5. Misty. 6. Fair. 7—9. Clear. 10—16. Fair. 17—19. Misty: rain. 20. Fair: rain. 21, 22. Rain. 23. Fair: misty. 24, 25. Showers, hail, and rain. 26. Showers. 27. Rain. 28. Showers. 29, 30. Fair: rain. 31. Fair.

Boston.—January 1. Fine. 2, 3. Cloudy. 4. Misty. 5. Cloudy. 6. Fine. 7. Fine: northern lights very brilliant in the evening. 8, 9. Fine. 10—16. Cloudy. 17. Cloudy: rain P.M. 18. Fine. 19. Misty. 20. Cloudy: stormy with rain P.M. 21, 22. Cloudy: rain at night. 23. Rain. 24. Cloudy. 25. Fine: snow early A.M. 26. Fine. 27. Cloudy. 28. Fine. 29, 30. Cloudy. 31. Fine.

Meteoro-

Meteorological Observations made by Mr. THOMPSON at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1831.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.									
Jan. 1	29·860	29·818	29·60	29·58	29·81	29·75	29·35	45	32	48	38	46	40	33·5	S.	SW.	S.	W.	...	...	...	0·020	...
2	29·909	29·868	29·60	29·55	29·83	29·81	29·50	44	31	51	43	44	39	36	W.	SW.	SE.	W.	...	...	0·265	...	...
3	29·950	29·918	29·70	29·70	29·87	29·86	29·57	41	35	49	47	44	40	34	S.	SE.	SE.	calm	0·10	...	...	...	...
4	29·935	29·886	29·70	29·70	29·85	29·81	29·60	38	36	48	45	45	38	35·5	SE.	SE.	E.	calm	...	...	...	...	...
☾ 5	30·037	29·899	29·72	29·68	29·97	29·80	29·60	39	30	52	44	43	33	37	E.	SE.	NE.	calm	...	...	...	...	...
6	30·518	30·250	30·40	30·20	30·40	30·21	29·88	40	24	44	40	40	28	33	NE.	E.	N.	NW	·10	...	...	...	...
7	30·665	30·641	30·50	30·50	30·60	30·57	30·23	40	21	44	34	39	26	30	S.	NE.	NE.	W.	...	...	...	...	...
8	30·653	30·431	30·50	30·50	30·57	30·50	30·20	33	25	42	32	37	29	29	SW.	NE.	NW.	calm	...	...	...	...	...
9	30·339	30·083	30·30	30·15	30·27	30·10	29·87	41	38	48	34	40	34	34·5	W.	NE.	NW.	calm	·07	...	...	...	...
10	30·065	29·937	29·95	29·95	29·92	29·89	29·60	41	33	47	42	42	34	39	NE.	NE.	N.	E.	...	·01	...	·020	...
11	30·159	30·121	29·95	29·95	30·06	30·03	29·70	37	30	40	34	37	34	37	NE.	NE.	NE.	calm	...	...	...	...	...
12	30·160	30·123	29·94	29·94	30·08	30·05	29·75	39	32	45	32	40	34	37	NE.	SE.	NE.	calm	·06	...	...	...	...
13	30·211	30·166	29·93	29·93	30·15	30·10	29·77	38	32	45	38	40	38	34	W.	SE.	E.	calm	...	...	...	...	...
● 14	30·221	30·152	29·93	29·90	30·15	30·10	29·80	39	31	43	40	41	34	38	E.	SE.	E.	calm	...	...	...	...	...
15	30·049	29·907	29·88	29·80	29·95	29·84	29·66	33	31	45	40	39	35	35·5	S.	SE.	E.	calm	·07	...	...	...	...
16	29·869	29·772	29·70	29·60	29·78	29·71	29·50	41	31	48	40	45	39	31	E.	SE.	E.	calm	...	·05	...	·160	...
17	29·647	29·618	29·50	29·50	29·58	29·55	29·40	45	33	49	44	48	40	37	E.	SE.	E.	calm	...	...	...	·005	...
18	29·650	29·553	29·55	29·40	29·62	29·52	29·26	46	33	51	46	48	45	40	SE.	SE.	S.E.	calm	·07	·13	...	·200	0·18
19	29·672	29·654	29·55	29·50	29·67	29·50	29·30	49	40	50	43	50	43	41·5	S.	SE.	S.	calm	...	·01	·130	·020	...
20	29·447	29·151	29·20	28·92	29·30	29·10	29·15	44	40	48	46	48	45	41	E.	SE.	E.	E.	...	·27	·060	·380	...
☽ 21	29·200	29·154	29·00	28·80	29·12	29·08	28·87	49	44	50	46	51	46	39	E.	SE.	SE.	E.	·08	·11	·145	·370	·22
22	29·276	29·241	29·20	29·10	29·22	29·17	28·93	50	46	49	46	49	46	41	E.	N.	SE.	E.	...	·10	·150	·540	·12
23	29·478	29·349	29·40	29·25	29·40	29·31	29·13	50	31	47	44	53	35	37	E.	NE.	SE.	E.	...	·12	...	·015	·76
24	29·657	29·519	29·70	29·60	29·60	29·51	29·21	34	29	42	37	39	29	35	N.	NE.	N.	NE.	·08	·02	·140	·060	·39
25	30·175	29·857	30·00	29·90	30·00	29·82	29·46	32	25	38	35	35	25	27	N.	NE.	N.	NE.	...	...	...	...	...
26	30·221	30·144	30·20	30·20	30·20	30·11	29·80	32	24	44	34	34	26	27	NE.	N.	NW.	NE.	...	...	·130	...	...
27	30·003	29·449	30·00	29·73	29·86	29·40	29·55	40	30	47	34	42	34	29	S.	N.	SW.	NW.	·08	·20	·300	·140	...
○ 28	29·766	29·707	29·80	29·80	29·73	29·70	29·36	38	30	47	41	39	27	27.5	N.	N.	NW.	NW.	...	...	·060	...	...
29	29·937	29·881	29·90	29·80	29·90	29·82	29·60	33	22	43	36	38	29	30	N.	SE.	E.	calm	...	...	·400	...	...
30	29·923	29·887	29·70	29·70	29·85	29·78	29·55	33	22	43	37	37	32	30	NE.	SE.	E.	calm	...	...	...	...	...
31	29·799	29·539	29·70	29·60	29·75	29·50	29·41	34	27	44	38	38	31	29	S.	SW.	SW.	calm	·14	...	·430	·370	...
	30·665	29·151	30·50	28·80	30·60	29·08	29·53	50	21	52	32	53	25	34·3					0·85	1·02	2·210	2·300	1·67

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

APRIL 1831.

XLI. *On the Computation of the Moon's Motion in Right Ascension. By* Francis Baily, *Esq. F.R.S. &c. &c.**

AS the method of determining the longitude of places, by means of moon-culminating stars, is daily coming into more general use, I trust the following table will be acceptable to such of your readers as may have occasion to make calculations connected with inquiries of that kind. I have already shown (in my paper on this subject, inserted in the Memoirs of the Royal Astronomical Society, vol. ii. p. 1), that "in order to deduce, from the observations, the correct difference of meridians between the two places, we require "only one element from the lunar tables, viz. the moon's "horary motion in right ascension; or, more properly, the "true increase of the moon's right ascension between the two "apparent times of culmination:" and that, for the purpose of determining the correct value of this element, it will be best, when the difference of longitude is very great, to compute the right ascension of the moon for the two given times of observation; using the equation of second, third, and sometimes even fourth differences. But it appears that in many cases, of frequent occurrence, where the difference of meridians does not exceed three hours, we may adopt a much more concise and easy method for the solution of the problem, by computing accurately the semi-diurnal motion of the moon in right ascension, from an ephemeris, by means of differences only.

In No. 33 of Professor Schumacher's *Astronomische Nachrichten*, M. Bessel has given a series which is applicable to this purpose; together with a short table of the value of that

* Communicated by the Author.

series, for every hour of the day. The table, however, which he has computed, being frequently found too limited for general use, I have here enlarged it, by calculating the terms of the series for every ten minutes during the day; whereby the requisite quantities for any intermediate time may be taken out almost on inspection; or at least, in the most essential points, with very little trouble: since it will seldom be found necessary to interpolate, except in the values given in the column B.

M. Bessel's formula is as follows; viz. make a, b, c, d, e respectively equal to the first difference, the mean of the two middle second differences, the third difference, the mean of the two fourth differences, and the fifth difference of the moon's right ascension, as taken from the Nautical Almanac. Then will

$$a + \frac{2n-1}{2}\, b + \frac{3n^2-3n+\frac{1}{2}}{6}\, c + \frac{4n^3-6n^2-2n+2}{24}\, d$$

$$+ \frac{5n^4-10n^3+5n-1}{120}\, e$$

denote the moon's semi-diurnal motion in right ascension corresponding to that fractional part of the twelve hours, from the *preceding* noon or midnight, indicated by n: and which must always be assumed equal to the middle point of time between the two observations. Or, preserving the same value of c and $\varkappa$ as are adopted in my Memoir above mentioned, the value of n must be assumed equal to $\frac{1}{2}(c + \varkappa)$. If therefore we express the co-efficients of b, c, d, e by the letters B, C, D, E, respectively, the semi-diurnal motion (M) of the moon in right ascension will be denoted by

$$M = a + Bb + Cc + Dd + Ee.$$

The following table contains the logarithms of B, C, D, E, for every ten minutes of the twelve hours from the preceding noon or midnight, as above mentioned; to which must be added respectively the logarithms of b, c, d, e; the natural numbers thence resulting, being added to the first difference, will give M, or the semi-diurnal motion required. And, retaining the value of the symbols x, s and Δ, as adopted in the Memoir above quoted, the true difference of longitude will be

$$x = \frac{7\frac{1}{2}s}{M}\Delta - \Delta$$

which is (I believe) the most simple form in which the general solution of the problem can be *at present* expressed: but, when the *new* Nautical Almanac appears, $7\frac{1}{2}s$ will be a constant

stant quantity, and equal to $7{\cdot}5 \times 86636{\cdot}555$ (log$=1{\cdot}4927720$); and other quantities will be given that may still further abridge the arithmetical operations.

Argument $=\frac{1}{2}(c+x)$	Logarithms of				Argument $=\frac{1}{2}(c+x)$
	B	C	D	E	
$0^h\ 0^m$	−9·69897+	+8·92082+	+8·92082−	−7·92082−	$12^h\ 0^m$
10	9·68674	8·88358	8·91452	7·89017	11 50
20	9·67415	8·84404	8·90759	7·85648	40
30	9·66118	8·80626	8·90003	7·81975	30
40	9·64782	8·75663	8·89188	7·78085	20
50	9·63403	8·70776	8·88307	7·73788	10
1 0	9·61979	8·65455	8·87361	7·69085	11 0
1 10	9·60506	8·59603	8.86347	7·64050	10 50
20	9·58983	8·53085	8·85259	7·58207	40
30	9·57403	8·45706	8·84096	7·51555	30
40	9·55764	8·37169	8·82845	7·45244	20
50	9·54061	8·26986	8·81520	7·36098	10
2 0	9·52288	8·14267	8·80121	7·24118	10 0
2 10	9·50440	7·97108	8·78709	7·07557	9 50
20	9·48509	7·70031	8·77180	6·83372	40
30	9·46489	+6·93855+	8·75534	−6·51562−	30
40	9·44370	−7.48946−	8·73650	+5·98986+	20
50	9·42142	7·83556	8·71619	6·73015	10
3 0	9·39794	8·01773	8·69442	6·97498	9 0
3 10	9·37312	8·13964	8·67203	7·10460	8 50
20	9·34679	8·22982	8·64795	7·21709	40
30	9·31875	8·30028	8·62217	7·31246	30
40	9·28880	8·35722	8·59442	7·37997	20
50	9·25661	8·40426	8·56398	7·43406	10
4 0	9·22185	8·44370	8·53085	7·47473	8 0
4 10	9·18406	8·47707	8·49507	7·51249	7 50
20	9·14267	8·50544	8·45486	7·54447	40
30	9·09691	8·52961	8·41021	7·57067	30
40	9·04576	8·55015	8·36245	7·59366	20
50	8·98777	8·56750	8·30477	7·61309	10
5 0	8·92082	8·58200	8·23716	7·62895	7 0
5 10	8·84164	8·59390	8·16105	7·64222	6 50
20	8·74473	8·60340	8·06131	7·65284	40
30	8·61979	8·61064	7·93794	7·66078	30
40	8·44370	8·61575	7·76219	7·66657	20
50	8·14267	8·61878	7·46136	7·66996	10
6 0	− ∞ +	−8·61979−	+ ∞ −	+7·67094+	6 0

I shall now proceed to give an example of the use of this formula and table, a duty which I hold to be incumbent on every person who proposes any new ones for general use. On the 9th of February 1830, the second limb of the moon was

 observed

observed at Greenwich at $13^h\ 36^m$ apparent time, and at the Cape of Good Hope at $12^h\ 20^m$ apparent *Greenwich* time; each being estimated to the nearest minute. Consequently the middle point of time, between the two observations, is $\frac{1}{2}(c + x) = 0^h\ 58^m$ from the preceding midnight: and the successive differences of the moon's right ascension, taken from the Nautical Almanac, will be as follow: viz.

		° ′ ″	*a*	*b*	*c*	*d*	*e*
Feb. 8.	at M =	154 31 52					
			+5 54 21				
9.	at N =	160 26 13		−5 8			
			+5 49 13		+51		
	at M =	166 15 26		−4 17		+7	
			+5 44 56		+58		−4
10.	at N =	172 0 22		−3 19		+3	
			+5 41 37		+61		
	at M =	177 41 59		−2 18			
			+5 39 19				
11.	at N =	183 21 18					

Therefore, by entering the table with the argument $\frac{1}{2}(c+x)$, we have the respective logarithms of the several quantities as under: viz.

$$\begin{array}{llll}
b = -2{\cdot}35793 & c = +1{\cdot}76343 & d = +0{\cdot}69897 & e = -0{\cdot}60206 \\
B = -9{\cdot}62264 & C = +8{\cdot}66519 & D = +8{\cdot}87550 & E = -7{\cdot}70026 \\
\hline
Bb = +1{\cdot}98057 & Cc = +0{\cdot}42862 & Dd = +9{\cdot}57447 & Ee = +8{\cdot}30232
\end{array}$$

and, taking the natural numbers of these logarithms, we shall find the value of M to be as follows: viz.

$$\begin{array}{lcrrr}
 & & {}^{\circ} & {}' & {}'' \\
a & = & 5 & 44 & 56{\cdot}000 \\
Bb & = & + & 1 & 35{\cdot}625 \\
Cc & = & + & & 2{\cdot}683 \\
Dd & = & + & & 0{\cdot}375 \\
Ee & = & + & & 0{\cdot}020 \\
\hline
M & = & 5 & 46 & 34{\cdot}703
\end{array} \quad (\log = 4{\cdot}3179526)$$

which is the moon's motion in right ascension for the twelve hours, of which $\frac{1}{2}(c+x)$ is the middle point of time. So that if we had $s = 24^h\ 3^m\ 57^s{\cdot}6$, and $\Delta = +\ 2^m\ 26^s{\cdot}315$, the operation would be as follows: viz.

$$\begin{array}{rr}
7\tfrac{1}{2}s = & 5{\cdot}8127677 \\
M = & 4{\cdot}3179526 \\
\hline
 & 1{\cdot}4948151 \\
\Delta = 0^h\ 2^m\ 26^s{\cdot}315 = & 2{\cdot}1652889 \\
\hline
\dfrac{7\frac{1}{2}s}{M}\ \Delta = 1\ \ 16\ \ \ 11{\cdot}976 = & 3{\cdot}6601040 \\
\hline
x = 1\ \ 13\ \ \ 45{\cdot}661 &
\end{array}$$

In

In this example, it will be seen that I have interpolated for the odd minutes, in order to show the method of obtaining, in all cases, the correct values of the logarithms of the table required: but it is evident that, with the exception of the logarithm of B, this was unnecessary; and that no error would have arisen if we had taken, even in all the quantities, the tabular values opposite to the nearest tenth minute. And I would further remark, that it will seldom be necessary to extend the series to so many terms as are here given: since we may generally stop at the third difference (and sometimes even at the second difference), if we see that the subsequent differences are not sufficiently large to affect the result.

Before I conclude, I would remark that the logarithms of D and E were calculated for every half hour only, and the values interpolated for the intermediate ten minutes, using second differences in the computations.

F. B.

XLII. *Errata in* Weisse's *Planetary Tables.* *By* A Correspondent.

THE number of individuals who in this country are engaged in science, except in what may not inaptly be designated as fancy-work [?], is so very limited, that considering the heavy duty on the importation of books*, it is a most hazardous speculation for a bookseller to introduce foreign scientific works into England. The consequence is, that many of the highest value in point of utility, but of which the sale would necessarily be limited, are either altogether unknown in this country, or have fallen into the hands of individuals without the means, or possibly the inclination, to bring their merits before the public. The industrious zeal of Mr. Baily and the hitherto discreditable state of our Nautical Almanac, led to the speedy adoption of Encke's Ephemeris; but the inestimable *Tabulæ Regiomontanæ Reductionum* of Bessel† have scarcely been heard of. The *Formeln der Geometrie und Trigonometrie*, published at Berlin in 1827, and Hesterman's most useful *Leges Trigonometriæ*, have met with no better fate. The

* While in Russia, a nation which we are accustomed to contemn as something more than semibarbarous, no duty, and in France a duty equivalent to only six shillings per hundred weight, is levied upon the importation of books;—in England, they are subjected to five pounds per hundred weight.

† This work, indispensable to practical astronomers, consists of one large octavo volume, printed with a degree of clearness which should serve as a model for all books of tables, and is published by Bachelier of Paris, and Treuttel, London.

same

same may be remarked of Bagay's Tables *, by far the cheapest and best volume of the sort which ever appeared; and as to Weisse's Planetary Tables†, we much doubt if two copies have as yet reached England. The compendious nature and simplicity of these tables are such as to recommend them especially to the notice of every astronomer, but their merits in these respects are counterbalanced by indistinct type and numerous errors, of which no corrections are furnished by the author. To supply this deficiency, and with a hope that a correct reprint of this convenient little book may either be undertaken here or introduced from the continent, a list is subjoined of all the errata in the more valuable parts of the work, detected by a complete and systematic examination.

Page 5.	*x* Aprilis 11	*pro* 0·9310		*lege* +0·9310
	z ——— —	0·1489		+0·1489
6.	*z* Julius 1	0·3989		+0·3989
	x —— 8	0·2839		0·2889
7.	*x* September 27	0·9679		0·9979
	x ——— 28	0·9661		0·9961
	y October 7	0·2395		0·2295
8.	Caret December 32			
	y December 32	0·8846		−0·8846
10.	1825, Long. Med. ☿	45·67		35·67
	1890 —— — —	235·80		352·80
	Dies 21	89·94		85·94
12.	*x* 1840, L. M. 84	0·00688		+0·00688
	y —— —— 55	9·20304		0·20304
	x 1900 —— 50	0·25071		0·25571
	x —— —— 84	+0·00954		0·00954
	x —— —— 85	−0·00130		+0·00130
	x —— —— 86	0·00695		−0·00695
13.	*x* 1840 —— 115	0·22801		0·22861
	y 1900 —— 95	0·26734		0·26634
	z 1840 —— 109	0·14145		0·14165
	z —— —— 110	0·14014	‡	0·14044
	z —— —— 111	0·13987		0·13917
	z —— —— 112	0·13773		0·13783
14.	*y* 1900 —— 145	9·05170		0·05170

* *Nouvelles Tables Astronomiques et Hydrographiques*, &c. Par V. Bagay: Didot, Paris; Treuttel and Würtz, London. 1 vol. 4to. The tables of sines, cosines, tangents and cotangents in this work, are to every second, and, both in form and size, much more commodious than those of Taylor.

† Coordinatæ Mercurii, Veneris, Martis, Jovis, Saturni et Urani. Calculatæ a Maximiliano Weisse. Cracoviæ, 1829. 4to. pp. 73.

‡ The three figures 4. 1. 8. have apparently slipped up each one line above its proper place.

Page 15.	y	1900 L.M.	202	*pro* 0·25783	*lege* 0·25743
	z	1840 — —	186	0·06741	0·05741
	z	——— — —	196	0·08530	0·08570
	z	——— — —	222	0·13982	0·14982
16.	z	——— — —	270	0·21528	0·21628
17.	z	1900 — —	274	0·21708	0·21808
	z	1840 — —	297	0·21759	0·21659
18.	y	1900 — —	316	0·33322	0·33422
	y	——— — —	324	9·30487	0·38487
	y	1840 — —	360	0·22178	0·12178
	z	——— — —	324	0·18786	0·18686

20. Mean longitude of Venus for 1897 is too great by 60 degrees, which error is continued in eighteen following years, when the table concludes.

21.	y	1840 L.M.	24	*pro* 0·27687	*lege* 0·27607
22.	x	1900 — —	85	0·07978	0·06978
	y	1840 — —	54	9·53721	0·53721
	y	——— — —	75	0·63652	0·63672
23.	x	——— — —	94	0·04141	0·04411
	x	1900 — —	107	0·20593	0·20598
	y	——— — —	100	0·64340	0·64344
	z	——— — —	104	0·29425	0·29625
	z	——— — —	111	0·28989	0·28979
24.	x	——— — —	141	0·55857	0·55867
	z	——— — —	172	0·07589	0·07586
25.	x	1840 — —	806	......	206
	x	——— — —	—	0·63396	0·64396
	y	1900 — —	186	0·09297	0·09267
	z	——— — —	225	+0·18682	−0·18682
	z	——— — —	218	0·15659	0·15669
	z	——— — —	219	0·15151	0·16115
26.	y	——— — —	263	0·65906	0·66006
	x	1840 — —	270	0·00591	+0·00591
27.	y	1900 — —	273	0·65062	0·66062
28.	y	1840 — —	348	0·12581	0·12681
	y	1900 — —	317	0·44005	0·44105
31.	x	1840 — —	34	1·05975	1·05675
32.	x	——— — —	83	0·07293	0·07193
	y	——— — —	80	1·48249	1·43249
33.	x	1900 — —	105	0·62644	0·62044
	y	——— — —	—	1·33717	1·35717
	z	——— — —	90	0·69339	0·66339
34.	y	1840 — —	142	0·87050	0·87850
35.	x	——— — —	183	1·64874	1·64847
	y	1900 — —	188	0·08357	0·08347

Page

Page 35.	*z* 1840 L.M.	225	*pro* 0·35333	*lege* 0·35233
36.	*y* 1900 — —	256	1·24136	1·25136
	y —— — —	270	1·32972	1·32072
37.	*x* —— — —	294	0·41073	0·40173
	x 1840 — —	303	0·03828	0·63828
	z 1900 — —	305	0·52670	0·52660
38.	*z* —— — —	319	0·42578	0·42568
	y 1840 — —	344	0·29525	0·28525
41.	*y* —— — —	11	0·91557	0·90557
	x 1900 — —	0	4·95565	4·95575
	x —— — —	5	4·98923	4·93923
42.	*z* —— — —	45	1·39792	1·39799
43.	*x* 1840 — —	99	1·30388	1·30488
44.	*y* —— — —	171	0·57831	0·57331
	y —— — —	165	1·04303	1·04403
45.	*x* 1900 — —	189	5·38999	5·37999
	x —— — —	201	5·10351	5·11351
46.	*x* —— — —	268	0·76718	0·66718
47.	*z* —— — —	270	2·06000	+ 2·06000
	y —— — —	279	4·71477	4·79477
	x 1840 — —	307	2·69500	2·69600
48.	*z* 1900 — —	355	0·33840	0·33340
	y 1840 — —	349	0·90487	1·00487
	x 1900 — —	316	3·24252	3·34252
	x —— — —	352	4·39146	4·89146
	x —— — —	360	4·95575	4·95565
50.	1870 — —		558·84	258·84
	Dies 14 — —		0·57	0·47
	—— 17 — —		0·47	0·57
52.	*z* 1900 — —	47	2·11362	2·11262
	z —— — —	61	2·77550	2·75550
	x —— — —	63	4·55187	4·56187
53.	*z* 1840 — —	98	3·46566	3·46166
	x —— — —	101	3·44592	3·44552
	y —— — —	105	7·95404	7·94404
	y —— — —	106	7·89445	7·89545
	x 1900 — —	106	3·75628	2·75628
	x —— — —	115	4·12127	4·22127
	x —— — —	120	5·98518	4·98518
	z 1840 — —	126	2·85286	2·89286
54.	*y* 1840 — —	158	2·22868	2·22898
	y 1900 — —	162	1·63508	1·63505
55.	*z* —— — —	182	0·13439	0·18439
	x —— — —	186	9·33824	9·38824
	z 1840 — —	190	0·66082	0·69082
	y 1900 — —	196	3·50969	3·50959

Page

Page 55.	*z* 1840 L. M.	210	*pro* 1·88164	*lege* 1·88162
56.	*x* —— ——	260	1·66498	1·56498
	z —— ——	269	3·55269	3·85269
57.	*x* —— ——	276	0·94451	0·94431
	z —— ——	297	3·95260	3·65260
58.	*x* 1900 ——	325	7·96512	7·56512
	z 1840 ——	348	1·00194	1·01194
	y 1900 ——	353	1·09789	1·89789
	z 1840 ——	356	1·00194	1·01194
60.	1831 ——		305·771	306·771
	1862 ——		79·026	80·026
	1911 ——		300·634	290·634
	1912 ——		304·941	294·941
	1913 ——		309·237	299·237
	1914 ——		313·532	303·532
	1915 ——		317·823	307·823
	Dies 23 ——		0·371	0·271
61.	*y* 1840 ——	0	0·23116	0·23119
	y —— ——	22	6·01925	6·09125
	y 1900 ——	8	2·12237	2·13237
	y —— ——	36	9·77758	9·77158
62.	*x* 1840 ——	61	10·90550	10·90450
	x —— ——	86	3·00897	3·09897
	x 1900 ——	82	4·42519	4·42919
	x —— ——	84	3·79818	3·76818
	x —— ——	90	1·76063	+1·76063
63.	*z* 1840 ——	101	7·56672	7·56572
64.	*x* —— ——	143	14·20512	14·20912
	x —— ——	144	14·42467	14·42267
	x —— ——	159	16·98680	16·98580
	x 1900 ——	163	17·44115	17·44415
	z 1840 ——	171	1·32734	1·32744
	x 1900 ——	180	+18·30949	−18·30949
66.	*x* 1840 ——	231	10·53344	10·55344
	x —— ——	251	4·81669	4·51669
	z —— ——	240	6·81877	6·81477
	x 1900 ——	259	1·86783	1·89783
67.	*z* —— ——	273	7·72260	7·76260
	x 1840 ——	313	14·43359	14·32359
68.	*y* —— ——	330	8·68794	8·64794

Chislehurst; Feb. 10th, 1831.

 XLIII. *On*

XLIII. *On the Rectification of Curves.* By Mr. CHARLES GILL.

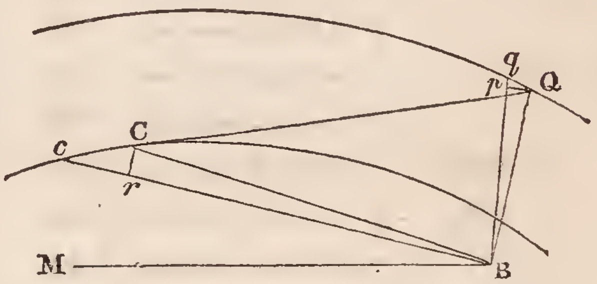
To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

WHILE investigating the properties of a family of curves, I was lately led to remark, that the elegant property demonstrated by Mr. Beverley, in your Number for June 1826, is capable of considerable extension. Under the idea that anything tending to the simplification of this abstruse problem will be viewed with satisfaction by your mathematical readers, I submit to you the result of my labours.

The proposition may be more generally enunciated thus: Let C be any point in a given curve line of any order, and B, a point any how given by position: join B C, and draw B Q, C Q to meet in Q, and contain a given angle (β), C Q being also a tangent to the curve. Then the rectification of the curve which is the locus of the point Q may be generally expressed by $\int$ D C cosec $\beta \,.\, d\,\theta$, θ being the angle B Q makes with a fixed axis, taken at pleasure.

Let B M be a fixed axis, and let $\angle$ M B C $= \varphi$, and C B Q $= \theta - \varphi$. Now whatever be the nature of the curve in which C moves, or the position of the point B, the equation of the curve may be expressed by B C $= \delta\,(\varphi)$ a function of the angle M B C, and given lines. Draw B c indefinitely near B C, and with centre B and radius B C describe the small arc Cr; then, in the elementary triangle Crc, we have



$\mathrm{C}r = \mathrm{BC}\,.\,d\varphi = d\varphi\,.\,\delta\,(\phi)$, $c\,r = -\,d\,\mathrm{BC} = -d\,\varphi\,.\,\delta'(\varphi)$, $\left(\text{putting } d\,\delta\,(\varphi) = d\,\phi\,.\,\delta'\,(\varphi)\right)$, and $\angle\,\mathrm{C}\,c\,r = 180° - \beta - \theta + \varphi$;

hence, $\tan\,(\beta + \theta - \phi) = -\,\dfrac{\mathrm{C}\,r}{c\,r} = \dfrac{\delta\,(\phi)}{\delta'\,(\varphi)}$ .... (α). Now

$\mathrm{B\,Q} = \dfrac{\delta\,(\varphi)}{\sin\beta}\,.\,\sin\,(\beta + \theta - \varphi)$, and forming, as before, the elementary triangle Q$\,p\,q$, we shall have $\mathrm{Q}\,p = \mathrm{B\,Q}\,.\,d\,\theta =$

$\dfrac{d\,\theta\,.\,\delta\,(\phi)}{\sin\beta}\,.\,\sin\,(\beta + \theta - \varphi)$, and $p\,q = d\,\mathrm{BQ} = \dfrac{1}{\sin\beta}\Big\{d\varphi\,.\,\delta'\,(\varphi)$

$.\,\sin\,(\beta + \theta - \phi) + d\,(\theta - \varphi)\,.\,\delta\,(\phi)\,\cos\,(\beta + \theta - \varphi)\Big\}$. But $d\,\varphi =$

$d\theta - d\,(\theta - \varphi)\ \therefore\ p\,q = \dfrac{1}{\sin\beta}\Big\{d\,\theta\,.\,\delta'\,(\varphi)\,.\,\sin\,(\beta + \theta - \phi) -$

$d\,(\theta -$

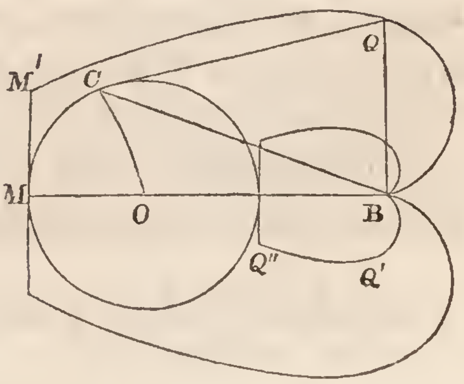
$d(\theta-\varphi)\left[\delta'(\varphi)\cdot\sin(\beta+\theta-\phi)-\delta(\phi)\cos(\beta+\theta-\phi)\right]\}$. But by ($\alpha$), $\delta'(\phi)\sin(\beta+\theta-\varphi)=\delta(\phi)\cos(\beta+\delta-\varphi)$; hence $pq = \frac{d\theta\,.\,\delta'(\phi)}{\sin\beta}\,.\sin(\beta+\theta-\varphi)$, and $Qq=\sqrt{Qp^2+pq^2}=\frac{d\theta}{\sin\beta}\,.\sin(\beta+\theta-\phi)\,.\sqrt{\delta^2(\phi)+\delta'^2(\phi)}=(by\,\alpha)\,\frac{d\theta}{\sin\beta}\,.\,\frac{\theta(\varphi)}{\sqrt{\delta^2(\varphi)+\delta'^2(\phi)}}\,.\sqrt{\delta^2(\phi)+\delta'^2(\varphi)}=\frac{d\theta\,.\,\delta(\varphi)}{\sin\beta}=d\theta\,.\,BC$ cosec β, and the rectification of the curve $=\int d\theta\,.\,BC\operatorname{cosec}\beta$.

Cor. 1. Hence, when $\beta=90^\circ$, the expression becomes $\int d\theta\,.\,BC$, the same as Mr. Beverley's; still however not restricting the pole to be at the *vertex* of the curves.

Cor. 2. Hence, while the generating curve and the pole remain the same, the length of the tangential curve is inversely as $\sin\beta$; for BC is independent of β; and $d\theta=d\phi+d(\beta+\theta-\varphi)$ is also independent of β.

Cor. 3. Hence also a neat method of drawing tangents to curves whose ordinates proceed from a fixed point; for we have only to draw CQ making with BC (the ordinate) an angle whose tangent $=\frac{d\,BC}{d\phi\,BC}$, and CQ is the required tangent.

Example. Let the curve in which C moves be the circle; and let $OC=a$, $OB=b$ (O being the centre), $OBC=\varphi$, &c. then $BC=\delta(\phi)=b\cos\varphi\pm\sqrt{a^2-b^2\sin^2\varphi}$ $\therefore\ \delta'(\phi)=-b\sin\varphi\mp\frac{b^2\sin\varphi\cos\phi}{\sqrt{a^2-b^2\sin^2\phi}}=\delta(\varphi)\,.\,\frac{\mp b\sin\phi}{\sqrt{a^2-b^2\sin^2\varphi}}$. Also $\tan(\beta+\theta-\varphi)=\frac{\delta(\varphi)}{\delta'(\varphi)}=\mp\frac{\sqrt{a^2-b^2\sin^2\varphi}}{b\sin\varphi}$, $\therefore$



$$d\theta=d\varphi+d(\beta+\theta-\phi)=d\phi+\frac{d\tan(\beta+\theta-\varphi)}{1+\tan^2(\beta+\theta-\phi)}=d\varphi\pm d\varphi\,.\,\frac{b\cos\varphi}{\sqrt{a^2-b^2\sin^2\varphi}}=\frac{\pm d\phi\,.\,\delta(\varphi)}{\sqrt{a^2-b^2\sin^2\varphi}}.$$

Hence the curve M$'$Q $=\int\delta(\phi)\operatorname{cosec}\beta\,.\,d\theta=\pm\operatorname{cosec}\beta\int\frac{d\varphi\,.\,\delta^2(\varphi)}{\sqrt{a^2-b^2\sin^2\varphi}}=$ cosec $\beta\left\{\int 2b\cos\phi\, d\varphi\pm\int d\phi\left[\frac{b^2\cos^2\varphi}{\sqrt{a^2-b^2\sin^2\varphi}}+\sqrt{a^2-b^2\sin^2\varphi}\right]\right\}$

= cosec

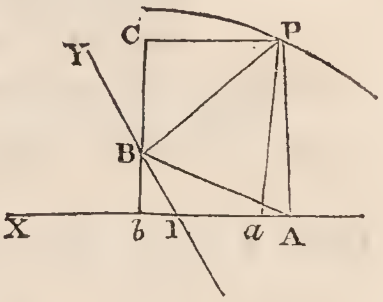
$= \operatorname{cosec} \beta \left\{ 2\, b \sin \phi \pm \dfrac{b^3}{2\, a} (\mathrm{E} - \mathrm{H} + \mathrm{T}) \right\}$. Where E = an elliptic arc, the semiaxes of which are $\dfrac{2\, a}{b}$ and $\dfrac{2\, a}{b^2} \sqrt{b^2 - a^2}$, and its abscissa from the centre $= 2 \sin \phi$; and H = the arc of an hyperbola whose semiaxes are $\dfrac{2\, a^2}{b^2}$, and $\dfrac{2\, a}{b^2} \sqrt{b^2 - a^2}$, and its tangent, T, terminated by a perpendicular upon it from the centre $= \dfrac{a \sin^2 \phi}{\sqrt{a^2 - b^2 \sin^2 \phi}}$. Which between $\phi = 0°$, and $\phi =$ arc whose sine is $= \dfrac{a}{b}$ becomes $= \operatorname{cosec} \beta \left\{ 2\, a + \dfrac{b^2}{2\, a} \right.$ (quadrantal arc of the ellipse + difference between the infinite arc of the hyperbola and its asymptote) $\left. \right\}$ for the length of the branch M Q B, and (using the under signs) the length of the other branch $\mathrm{P\,Q'\,Q''} = \operatorname{cosec} \beta \left(-2a + \dfrac{b^2}{2\, a} \times \right.$ the above factor) hence the whole length of the curve = twice the sum of these $= \dfrac{2\, b}{a} \operatorname{cosec} \beta$ (quadrant of the elliptic arc + excess of the asymptote of the hyperbola, infinitely produced). When B is in the circumference, or $b = a$, E becomes = its abscissa, and T − H = semi-transverse of the hyperbola ∴ whole length $= 8\, a \operatorname{cosec} \beta$, the same as Mr. Beverley's, when $\beta = 90°$.

This integral only applies when B is without the circle, or $b > a$: when $b < a$, we shall have $\mathrm{M'Q} = \operatorname{cosec} \beta \int d\phi \left(2b \cos \phi + \dfrac{a^2 + b^2 \cos 2\phi}{\sqrt{a^2 - b^2 \sin^2 \phi}} \right) = \operatorname{cosec} \beta \left\{ 2\, b \sin \phi + \dfrac{b^2 \sin 2\phi}{\sqrt{a^2 - b^2 \sin^2 \phi}} - b (\mathrm{E} - \mathrm{H} + \mathrm{T}) \right\}$; and here the semiaxes of E are $\dfrac{a}{b}$, and $\dfrac{\sqrt{a^2 - b^2}}{b}$, and its abscissa $= \dfrac{a^2 \cos \phi}{b \sqrt{a^2\, b^2 \sin^2 \phi}}$; the semiaxes of H, 1 and $\dfrac{\sqrt{a^2 - b^2}}{b}$, and $\mathrm{T} = \dfrac{-a^2 \cot \phi}{b \sqrt{a^2 - b^2 \sin^2 \phi}}$. This, between $\phi = 0°$ and $\phi = 180°$, gives the length of half the curve $= b \operatorname{cosec} \beta$ (semi-periphery of the ellipse + difference between the two asymptotes and the arc of the hyperbola, both

both ways infinitely produced). When $b = 0$, the curve is a circle to radius a cosec β.

Scholium. The following formulæ for transferring the equation of a curve from one pole to another, are useful in these and many other problems; they have never, to my knowledge, been published.

Having given the equation of the curve to the pole A and axis AX, to find its equation when referred to the pole B, and axis BY; the position of A and B being given:



Let A X, B Y intersect in I, making $\angle$ XIY $= \chi$; and put XAP $= \phi$, YBP $= \theta$, IAB $= \beta$, and AB $= a$: then the two equations may be expressed, functionally, thus: AP $= \delta(\phi)$ and BP $= \delta'(\theta)$. Draw Pa, Bb $\angle$ AX, and complete the parallelogram abcP; then P$a = \delta(\phi)\sin\phi$, A$a = \delta(\phi)\cos\phi$; B$b = a\sin\beta$, A$b = a\cos\beta$; P$c = -\delta'(\theta)\cos(\theta+\chi)$, and B$c = \delta'(\theta)\sin(\theta+\chi)$. $\therefore$ $\delta(\phi)\sin\phi = a\sin\beta - \delta'(\theta)\cos(\theta+\chi)$ ... $\therefore$ (α), and $\delta(\phi)\cos\phi = a\cos\beta - \delta'(\theta)\sin(\theta+\chi)$.

$\therefore \tan\phi = \dfrac{\alpha\sin\beta - \delta'(\theta)\cos(\theta+\chi)}{\alpha\cos\beta - \delta'(\theta)\sin(\theta+\chi)}$. This value of ϕ and the proper value of $\delta(\phi)$ substituted in (α) will give $\delta'(\theta)$ in terms of θ and known quantities as it ought to be.

I am, Gentlemen, your obedient humble servant,

Seamen, near Scarborough, Sept. 6th, 1830. CHARLES GILL.

XLIV. *Remarks on the Demonstrations of the Theorems of* Lagrange *and* Laplace, *given by* Dr. Lardner *and* M. Lacroix *for the Expansion of Functions; with a Demonstration of those Theorems. By Mr.* JAMES GORDON.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I SEND you the following remarks upon the demonstrations of the theorems of Lagrange and Laplace, for the expansion of functions, in order that some of your correspondents who are conversant with these subjects may correct my views if erroneous.

The demonstrations referred to are contained in the two treatises on the Differential and Integral Calculus, by Dr. Lardner and M. Lacroix; in the latter the demonstration is given by Mr. Peacock in one of his excellent notes to the work.

And

And as I am not aware that there is a satisfactory demonstration of either of these theorems in our language, I have annexed one, which, excepting some alterations, is the same as that given in the quarto edition of Lacroix, on the Differential and Integral Calculus, vol. i. Art. 107.

I have the honour to be, &c.

JAMES GORDON.

Public Commercial and Mathematical School, Aberdeen.

1st. Remarks on the Demonstrations of the Theorems of Lagrange and Laplace as given in the above-mentioned Treatises.

Using the same notation as in the note to Lacroix: v, v^2, v^3, &c. (page 637) are there put $= p, p^2, p^3$, &c. when $x = 0$. Now although $\frac{x^2}{1\,.\,2}\left\{q_2 p' + 2\,q_1 p_1 v\right\}$ becomes $\frac{x^2}{1\,.\,2}\left\{q_2 p' + 2\,q_1 p' p\right\}$ when $x = 0$; yet, since $v = p + p_1 v x$ $+$&c., will not the coefficient of that term of v which contains the first power of x, go to the formation of the coefficient of $\frac{x^3}{1\,.\,2\,.\,3}$ and not vanish? but, by making v actually $= p$, this part of the coefficient will be lost.—A similar observation applies to the other coefficients.

If I am correct in this remark, the demonstration of Lagrange's theorem, beginning at that part which is near the bottom of page 636, will be as follows.

Consequently,

$$\begin{aligned}
u = {} & q \\
& + x\{q_1 p\} \\
& + \frac{x^2}{1\,.\,2}\left\{q_2 p' + 2 q_1 p_1 p\right\} \\
& + \frac{x^3}{1\,.\,2\,.\,3}\left\{q_3 p'' + 3 q_2 p'_1 p + 3 q_1 p_2 p' + 6 p\,(p_1)^2 q_1\right\} \\
& + \frac{x^4}{1\,.\,2\,.\,3\,.\,4}\left\{q_4 p''' + 4 q_3 p''_1 p + 6 q_2 p'_2 p' + 4 q_1 p_3 p'' + \right. \\
& \left. 12 p_1 p_2 p' q_1 + 24\,(p_1)^3 p\, q_1 + 12 q_2 p'_1 p p_1 + 12\, q_1 p_2 p'_1 p\right\} \\
& + \text{\&c.}
\end{aligned}$$

But $q = f(z)$

$$q_1 p = p\,.\,\frac{d\,q}{d\,z} = \phi\,(z)\,.\,\frac{d\,.\,f\,(z)}{d\,z}$$

And,

And, since

$$d^n.(xy) = d^n x.y + n\, d^{n-1} x.dy + n.\frac{n-1}{2}\, d^{n-2} x.d^2 y + \&c.$$

we obtain the following results:

$$q_2 p' + 2 q_1 p_1 p = \frac{d.p'^2 \frac{dq}{dz}}{dz} = \frac{d.\left\{\phi(z)^2.\frac{df(z)}{dz}\right\}}{dz}.$$

$$q_3 p'' + 3 q_2 p'_1 p + 3 q_1 p_2 p^2 + 6p(p_1)^2 q_1 = q_3 p'' + 2 q_3 p''_1 + q_1 p''_2 = \frac{d^2.p^3 \frac{dq}{dz}}{dz^2} = \frac{d^2.\left\{\phi(z)^3.\frac{df(z)}{dz}\right\}}{dz^2}$$

$$q_4 p''' + 4 q_3 p''_1 p + 6 q_2 p'_2 p' + 4 q_1 p_3 p'' + 12 p_1 p_2 p' q_1 + 24 (p_1)^3 p\, q_1 + 12 q_2 p'_1 p\, p_1 + 12 q_1 p_2 p'_1 p$$

$$= q_4 p''' + 3 q_3 p'''_1 + 3 q_2 p'''_2 + q_1 p'''_3 = \frac{d^3.p^4 \frac{dq}{dz}}{dz^3} = \frac{d^3.\left\{\phi(z)^4.\frac{df(z)}{dz}\right\}}{dz^3} \quad \&c.\ \&c.$$

Hence the theorem is obtained.

2ndly. Demonstration of the theorems of Laplace and Lagrange.

Lemma.—Let t be a function of y and $= z + xf(y)$, where z and x are independent variables; also let u_1 be any other function of y:

$$\text{then} \quad \frac{d^n u_1}{dx^n} = \frac{d^{n-1}.f(y)^n \frac{du}{dz}}{dz^{n-1}}.$$

Case 1st, when $n = 1$.

For, $\frac{dt}{dx} = \frac{dt}{dy}.\frac{dy}{dx}$ and $= f(y) + x.\frac{df(y)}{dy}.\frac{dy}{dx}$;

$$\text{hence} \quad \frac{dy}{dx} = \frac{f(y)}{\frac{dt}{dy} - x\frac{df(y)}{dy}}.$$

Also, $\frac{dt}{dz} = \frac{dt}{dy}.\frac{dy}{dz}$ and $= 1 + x.\frac{df(y)}{dy}.\frac{dy}{dx}$;

$$\text{hence,} \quad \frac{dy}{dz} = \frac{1}{\frac{dt}{dy} - x.\frac{df(y)}{dy}}.$$

$$\therefore \frac{dy}{dx} : \frac{dy}{dz} :: f(y) : 1.$$

But,

But, $\frac{d u_1}{d x} = \frac{d u_1}{d y} \cdot \frac{d y}{d x}$ and $\frac{d u_1}{d z} = \frac{d u_1}{d y} \cdot \frac{d y}{d z}$

$$\therefore \frac{d u_1}{d x} : \frac{d u_1}{d z} :: \frac{d y}{d x} : \frac{d y}{d z} \text{ or } :: f(y) : 1$$

$$\text{hence } \frac{d u_1}{d x} = f(y) \frac{d u_1}{d z}.$$

Case 2nd, when $n = 2$.

By Case 1st, $\frac{d u_1}{d x} = f(y) \frac{d u_1}{d z} = f(y) \frac{d u_1}{d y} \cdot \frac{d y}{d z}$; where $f(y) \frac{d u_1}{d y}$ is a function of y, and we may regard it therefore as the differential coefficient of a new function of y which we represent by u_2, so that $\frac{d u_2}{d y} = f(y) \frac{d u_1}{d y}$, $\therefore \frac{d u_2}{d z}$ being $= \frac{d u_2}{d y} \cdot \frac{d y}{d z}$ will be $= f(y) \frac{d u_1}{d y} \cdot \frac{d y}{d z} = f(y) \frac{d u_1}{d z}$. Consequently $\frac{d u_1}{d x} = \frac{d u_2}{d z}$; and differentiating, $\frac{d^2 u_1}{d x^2} = \frac{d^2 u_2}{d x \cdot d z} = \frac{d^2 u_2}{d z\, d x} = \frac{d \cdot \frac{d u_1}{d x}}{d z}$; but by Case 1st $\frac{d u_2}{d x} = f(y) \frac{d u_2}{d z}$, and we proved that $\frac{d u_2}{d z} = f(y) \frac{d u_1}{d z}$, therefore, by substitution, $\frac{d^2 u_1}{d x^2} = \frac{d \cdot f(y)^2 \frac{d u_1}{d z}}{d z}$.

3rd Case. In general if $\frac{d^{n-1} u_1}{d x^{n-1}} = \frac{d^{n-2} \cdot f(y)^{n-1} \frac{d u}{d z}}{d z^{n-2}}$, then $\frac{d^n u}{d x^n} = \frac{d^{n-1} f(y)^n \frac{d u}{d z}}{d z^{n-1}}$.

For a similar reason to that given in Case 2nd, for introducing u_2, we may suppose u_{n-1} such a function of y, that $\frac{d u_{n-1}}{d z} = f(y)^{n-1} \frac{d u}{d z}$; but by hypothesis $\frac{d^{n-1} u_1}{d x^{n-1}} = \frac{d^{n-2} \cdot f(y)^{n-1} \frac{d u}{d z}}{d z^{n-2}}$, therefore by substitution $\frac{d^{n-1} u_1}{d x^{n-1}} = \frac{d^{n-1} u_{n-1}}{d z^{n-1}}$;

and,

and, differentiating, $\frac{d^n u_1}{d x^n} = \frac{d^n u_{n-1}}{d x \, . \, d z^{n-1}} = \frac{d^n u_{n-1}}{d z^{n-1} \, d x} =$

$$\frac{d^{n-1} \, . \, \frac{d u_{n-1}}{d x}}{d z^{n-1}} \, .$$

Now, by Case 1, $\frac{d u_{n-1}}{d x} = f(y) \frac{d u_{n-1}}{d z}$, and by supposition $\frac{d u_{n-1}}{d z} = f(y)^{n-1} \frac{d u}{d z}$; hence by substitution we obtain

$$\frac{d^n u}{d x^n} = \frac{d^{n-1} f(y)^n \frac{d u}{d z}}{d z^{n-1}} \, .$$

From which we may now infer the truth of the lemma.

Laplace's Theorem.—If $y = \mathrm{F}[z + x \, . \, f(y)]$ and $u_1 = \varphi(y)$; also if $\varphi\{\mathrm{F}(z)\} = \mathrm{F}_1(z)$ and $f\{\mathrm{F}(z)\} = f_1(z)$; then

$$u_1 = \mathrm{F}_1(z) + f_1(z) \frac{d \mathrm{F}_1(z)}{d z} \, . \, \frac{x}{1} + \frac{d \, . \, f_1(z)^2 \frac{d \mathrm{F}_1(z)}{d z}}{d z} \, \frac{x^2}{1 \, . \, 2} + \&\text{c.}$$

the nth term being $\frac{d^{n-2} \, . \, f_1(z)^{n-1} \frac{d \mathrm{F}_1(z)}{d z}}{d z^{n-2}} \, . \, \frac{x^{n-1}}{1 \, . \, 2 \, . \, 3 \, . \, . (n-1)}$.

For by Maclaurin's theorem $u_1 = \mathrm{U}_0 + \frac{d u_1}{d x_0} \, . \, \frac{x}{1} + \frac{d^2 u_1}{d x_0^2} \, . \, \frac{x^2}{1 \, . \, 2} + \&\text{c.}$, the nth term being $\frac{d^{n-1} u_1}{d x_0^{n-1}} \, . \, \frac{x^{n-1}}{1 . 2 . 3 . . (n-1}$ where U_0, $\frac{d u_1}{d x_0}$, $\frac{d^2 u_1}{d x_0^2}$ &c. represent what u_1, and its differential coefficients become when $x = 0$.

Now, since $y = \mathrm{F}[z + x f(y)]$, $\therefore$ some function of y must be $= z + x f(y)$; we therefore have by the lemma

$$\frac{d^n u_1}{d x^n} = \frac{d^{n-1} \, . \, f(y)^n \frac{d u_1}{d z}}{d z^{n-1}} \, .$$

We may now evidently infer the truth of the theorem.

Lagrange's Theorem.—If $y = z + x f(y)$ and $u_1 = \varphi(y)$; then the preceding theorem becomes $u_1 = \varphi(z) + f(z) \frac{d \varphi(z)}{d z}$

$$. \, \frac{x}{1} + \frac{d \, . \, f(z)^2 \frac{\varphi(z)}{d z}}{d z} \, . \, \frac{x^2}{1 \, . \, 2} + \&\text{c.}$$

XLV. *An Examination of those Phænomena of Geology, which seem to bear most directly on theoretical Speculations. By the Rev.* W. D. Conybeare, *M.A. F.R.S. F.G.S. &c.* (Part II.)

[Concluded from page 197.]

Art. II. THE configuration of the valleys which appear to have resulted from excavation, especially the intersection by transverse valleys of continuous longitudinal valleys, themselves opening possible outlets to the drainage,—is inconsistent with the theory which assigns the drainage of the atmospherical waters as the excavating agent.

Observations.—If any difficulty should be felt at first sight in exactly appreciating any of the terms employed in the above short general enunciation of the principle here maintained, I shall trust fully to explain them in proceeding with the detail. In the first place, I would propose to class our valleys according to the apparent difference of their probable origin; although the excavating action of water may very probably have materially modified them generally, yet it would be clearly inconsistent with the phænomena to refer their origin exclusively to this cause; the convulsive forces which have acted on the surface of our planet have often dislocated its strata, elevating one portion and depressing another from the level of their planes of deposition, and again contorting and bending them into the zigzag form of the letter (W). Now in the first case the lines of subsidence, and in the second the concave reentering angles, would naturally form valleys; these I would term generally valleys of dislocation: or if it should be expedient to distinguish those referable to the one or the other of the above cases, they may be characterized as valleys of subsidence or of contortion*. On the other hand, the valleys traversing the districts of which the nearly horizontal strata are scarcely at all affected by dislocation†, cannot have originated in such causes; and if there be sufficient grounds for believing the strata to have been originally continuous, we must of course suppose the valleys actually intersecting them, to have

* While I am sending these lines to the press, an interesting analysis of Professor Sedgwick's paper read at the Geological Society, On the Cumberland district, has appeared in your last Number. He describes the valleys in that district as valleys of dislocation.

† These nearly horizontal strata having been deposited at the bottom of the sea, appear indeed to have been subsequently raised by some elevating force: but in this case, such a force must have acted gradually and uniformly, so as not to dislocate their planes (which remain perfectly conformable), or disturb their relative levels. Now in the objections which Mr.

have been formed by excavation. Moreover this account of their origin seems to follow as an almost necessary corollary from the phænomena, of the gravel derived from the water-worn fragments torn from the mass of those strata, which were detailed in the foregoing article: for the existence of this gravel obviously presupposes the partial destruction of the strata which yielded it.

I shall now, then, more particularly examine the physical structure of the districts which are thus especially affected by valleys of excavation.

These districts are occupied by strata disposed in planes approximating to the horizontal, from which they seldom deviate more than 5° or 6°; their emergence from the superstrata, therefore, usually forms acclivities of gentle slope along the back of the strata; their termination against the substrata (or, as it is technically termed, their basset edge) presents, on the contrary, an abrupt escarpment, traversing the strata. Beneath these escarpments, therefore, we generally find extended valleys ranging in a direction parallel to the strata, which have usually been distinguished as longitudinal valleys. But besides these, other systems of valleys occur cutting across the ridges presented by the escarpments of the basset at nearly right angles. Now as these strata usually, at one extremity at least of their course, abut against an oceanic basin, the longitudinal valleys naturally appear to open one line of drainage: that presented by the transverse valleys is, however, the channel usually pursued by the actual rivers. In my paper before alluded to on the Valley of the Thames, I have shown that its waters thus cut transversely through three chains, which seem to oppose themselves as barriers to their course, although the longitudinal valleys ranging at the base of those barriers appear to open more obvious outlets to the drainage; and it is quite obvious, that since those longitudinal valleys have existed, the waters could never have risen within several hundred feet of the summits of the chains, over which on the fluvial hypothesis they are once supposed to have flowed. It must be argued, then, that at first no such longitudinal valleys existed; that is, that the strata did not, as at present, terminate

Mr. Lyell has urged to some of the arguments which the geologists of my school employ,—such as the transport of gravel, &c. in directions contrary to the actual drainage of the valleys,—he seems to have overlooked the distinction between such districts, and those of inclined and dislocated strata; for the examples have been taken from the more horizontal districts: to which his remark, that we may suppose the actual drainage to have been altered from that which originally prevailed, by earthquakes, &c. will not apply.

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in abruptly escarped basset edges, but that their planes were prolonged so as to expire insensibly against the more elevated portions of the substrata, which, on emerging, usually rise to higher levels;—so that the whole surface at first presented one uniform declivity, nearly uninterrupted. The Fluvialists must then suppose that the drainage across this declivity excavated the transverse valleys as its main channels, while the lateral drainage into these main channels excavated the longitudinal valleys. But in order to constitute the supposed original uniform declivity, the mass of materials formerly upfilling the whole space, and which we must imagine to have been subsequently removed, is stupendously great; for these longitudinal valleys usually present very extensive plains at the foot of the basset escarpments, whereas the transverse valleys are comparatively narrow defiles. If then we attribute the latter to the main course of drainage, and the former to its lateral action, we attribute an inferior effect to what must surely be considered as the most favourable line of action, and a vastly superior effect to that least favourable. I would refer to the analysis of my paper on the Thames, in your Magazine for July 1829, for the particulars of my argument, as far as that district affords any grounds of illustration.

With regard to the evidence then adduced, it was remarked by a writer, anxious at the same time to point out the necessity of confining the inferences so as to leave untouched all the districts in which facts of an opposite tendency might be observed, "similar facts are supplied by nearly all the greater valleys of England; and on the whole they point to one conclusion, that fluviatile erosion, as a mere solitary agent, has produced but small effects in modifying the prominent features of our island." (President Sedgwick's Address to the Geological Society, 1830.) Mr. Lyell, on the contrary, in a passage apparently designed as an allusion to this paper, has objected to reasoning from the actual form of the surface in any given district as to what may have taken place (as to drainage, &c.) under the original configuration of the district, which he conceives may have been entirely different. I can only reply, that the actual configuration must in some manner have resulted from that original one. He supposes the agent employed in the transformation to have been fluviatile erosion. Now the scope of my argument was intended to prove that no original form of surface could be assigned from which fluviatile erosion could have educed the actual form. This, I repeat, was the aim of my argument; whether or not I succeeded in that aim is another question. On this, as on other controverted subjects, temperate discussion can alone elicit truth; and I shall feel gratified

tified if any Fluvialist shall hereafter undertake the examination of the same phænomena, and explain in detail, on his own hypothesis, the exact manner in which the valleys of the Thames and its tributaries can have been formed.

Lest it should be imagined that the circumstances of this river are in any manner peculiar, I will add a short examination of the various streams which traverse the portion of our island occupied by the more horizontal strata, and in which therefore the valleys are attributable to excavation rather than dislocation. This district, as it is known, extends diagonally across the island, from the south of Durham to the east of Devon; the more horizontal formations occupying all the tract south-east of the diagonal line. Beginning our examination at the north extremity, the Derwent and its tributaries first present themselves.

1. First, as to the Rye,—Did not a transverse valley open across the oolitic chain of the Howardian hills, the waters of Ryedale would form a lake discharging itself along the Vale of Pickering at the base of the chalk escarpment, into Filey or Scarborough bay.

2. Had not the great transverse breach between the chalk wolds of Lincolnshire and Yorkshire given vent to the outlet of the Humber, all the flats near the junction of the Trent and Derwent would have formed an immense lake, whose waters would have been so dammed up as to have flooded all the lower portions of the Ouse and Swale, and discharged themselves finally by the mouth of the Tees; as the escarpments of the chalk wolds, and afterwards of the eastern moorlands, would have presented an insuperable barrier, preventing any other egress to the sea basin excepting Teesdale, previously to their fracture by transverse valleys. Now in order to get over this difficulty, the Fluvialist must, I conceive, argue that at the time when his streams commenced their operations, the said escarpments presented no barriers at all, all the valleys on the west of them having been at that period filled up (by materials since removed) to such a level as to overtop the chalk and oolitic ranges; since by such a configuration of surface alone could the streams have been brought to act on these ranges so as to cut transversely through them. Let the Fluvialist, however, so reconstruct the district in question: I next ask what it will require to reduce it from this "its form ten million years ago" to its actual features? Why simply the excavation of the entire vales of Lincoln and York (a district about 100 miles long and more than 15 broad) to a depth of 700 feet beneath its supposed original level. I will ask but one other question, How long would atmospherical drainage take to effect

this?

this? Seeing that since the Romans occupied Eboracum 1700 years ago, that agency has not effected a degradation of 7 inches on any one of the valla of their encampments, we may perhaps have sufficient data to calculate upon. I leave the Fluvialists to work out the question at leisure, offering in the meanwhile, as a mere approximation, an infinitillion of ages in the *n*th power.

3. We next come to the breach of the river Witham, through the oolitic range at Lincoln, where a dam of very trifling elevation would at once turn it into the Trent.

5. South of this the oolitic range is broken through by the transverse valleys of the Welland and Nen: but as the head waters of these streams rise almost within the limits of these valleys, I shall not insist on them; though as the breaches traverse the whole chain, I do not see how the Fluvialist can account for them without filling up the subjacent plains on the north-west as before.

6. I now arrive at my old ground, the district containing the Cherwell and other head waters of the Thames; and must refer to my former observations.

7. The chalk range is broken through not only by the Thames, but by a very considerable number of valleys, a complete transverse valley occurring almost every 10 miles throughout the course of that formation. Many of these valleys afford a passage to actual streams; and many others, quite an equal number I believe, are totally destitute of such rivers, and yet bear every character of being truly valleys of excavation. The chalk, indeed, as must be familiar to those who have resided long in any district chiefly composed of it (the locality of much of my own youth), abounds in valleys devoid of water, the stratum being so absorbent as generally at once to swallow up the atmospheric showers without allowing them to collect into rills. Now I very earnestly wish that the Fluvialists would inform me how these valleys, which neither have nor ever have had streams flowing through them, have been formed by the erosion of the said non-existing streams.

8. The valleys of excavation at the south-western extremity of our district, Dorset and Devon, have been fully described in an essay by my friend Buckland in the Geological Transactions, vol. v.; and wherever he has preceded me, I am always content with reference only.

9. I will conclude therefore with the south-eastern extremity, the Weald of Kent. It is well known that the axis and saddle of this district consists of a range of sand denominated (from the place where it terminates on the coast) the Hastings Sand. Round this axis mantle the upper and ferruginous green sand

sand and the chalk. On the north, both these formations form chains of steep escarpment separated by deep longitudinal valleys from the central axis and from each other: but on the south, from the general degradation of the sand, the chalk alone forms a regular escarpment. Now most of the main streams of this district have their head waters in the central axis; whence those running northwards into the Thames have to intersect by transverse valleys the two barriers of the Kentish rag hills and of the northern chalk downs, neglecting the two intervening longitudinal valleys, into which a dam of less than 100 feet high erected in any of these breaches, which are about 600 feet high, would turn the drainage towards the Straits of Dover. Such are the circumstances of the Wey, the Mole, and the Medway; the Darent and the Stour rising almost within the limits of the rag hills, indeed, can scarcely be said to break through more than one of these barriers, the chalk. On the south side we have the Arun, the Ader, the Ouse, and the Cuckmere, which in like manner break through the single opposing barrier of the chalky South Downs (as the sands do not on this side present a regular escarpment). Now it is I think quite inconceivable that fluviatile erosion could possibly have produced such a configuration, unless we suppose that the surface originally, when the drainage commenced its work, presented uniform slopes from the central axis to the æstuary of the Thames on the one side, and the sea on the other, the intermediate longitudinal valleys having been then filled up; and that while the direct drainage excavated the transverse valleys, the lateral drainage excavated the longitudinal valleys: in which case I would ask, first, why has the lateral drainage produced so much more considerable effects than the direct drainage? and secondly, how has it happened that the lateral drainage into so many distinct main channels has coincided so as to form one uniform longitudinal valley, instead of ramifications extending from one principal stream without any relation to those of the next principal stream? While the geologist is studying the valleys, the antiquary will observe throughout this tract the boldest prominences of the escarpments studded with ancient earthworks, which, though placed in the most exposed situations, have resisted the action of atmospherical causes for some twenty centuries: and should the two parties meet under these circumstances, it will be somewhat difficult for the former to persuade the latter that these deep defiles have been worn down by an agency which his own observations naturally lead him to believe to be next to null.

But it may well be said that the Diluvialist, if he thus assails the

the theory of the Fluvialist, is bound in fairness to state his own, that it may lie equally open to investigation. I shall endeavour to do so then, premising that while I frankly combat that which appears to me improbable, I can only pretend to suggest that which to me appears more probable; and that should I fail in this, in the opinion of others, it by no means follows that fluvialism is the correct explanation. As to my own views, then, I offer them simply as those of one individual, often, I am sensible, likely to require correction; and when that is not the case, yet susceptible of a far better development than any I can give them.

In the first place, then, as to the longitudinal valleys and the basset escarpments of the strata bounding them. It seems very possible that this configuration of surface is not exclusively and entirely to be ascribed to excavation, although its features may have been greatly modified and exaggerated by this operation. We may easily conceive forces in action during the period of the original deposition of the strata, which may have caused the strata to terminate with truncated edges, facing towards the elevated ridges of the older rocks, against and upon which they were precipitated, instead of having allowed their planes uniformly to extend until they abutted against those older ridges: for we must suppose the oceans which deposited these strata to have possessed some lines of shore; these we may naturally conceive to be indicated by the most elevated crests of the older ridges: against such lines of coast, currents most probably have ranged. While therefore the depositions were proceeding quietly in the deeper and more tranquil waters, they would be interrupted in the range of these littoral currents,—may not the longitudinal valleys have originated in this cause? The usual disposition of the actual submarine sandbanks is, I believe, analogous; they are cut off from the coasts by deep intervening channels, beyond which they rise with escarpments often of considerable abruptness.

To examine into the causes which may have modified and increased these longitudinal valleys, and produced the transverse defiles, we should, I apprehend, in the first place proceed regularly to investigate what would be the probable action of the waters in their gradual retreat from the summits of the strata originally formed beneath them to their present level. We have reason, with regard to the more horizontal strata, to which our attention is now confined, to conclude, from the conformity of the stratification and absence of dislocation, that the elevating forces must have in this instance proceeded with an uniform and gradual action, and consequently that the retreat of the sea and relative depression of its level would

would be likewise gradual. Now the lines indicating the main direction towards which the waters in their subsidence must tend, being coincident with the dip of the strata over the backs of which the descent was taking place, must of course have been transverse to the bearing of those strata: the general currents of the so descending waters would therefore naturally tend to produce transverse furrows in the strata: hence would the transverse valleys originate; while at the same time the longitudinal valleys would be materially modified; the descending currents setting against the escarpments of the strata would naturally tend to undermine them, and from the direction of the inclination of their planes would act to advantage, especially as we usually find the longitudinal valleys extending into the softer alternating strata, such as clay, and sand, and the harder rocks constituting the overhanging escarpment: hence the undermining agency of the waves operating with facility on these softer materials, would considerably increase the breadth of the longitudinal valleys and render the escarpments steeper and more abrupt. In proportion as the depression of the sea-level was gradual, there may have been a long continued reiteration of tidal waves sweeping over the same tracts. I happen at the present moment to have directly beneath my eyes a complete illustration of the necessary consequences of the action of tidal waves on strata gradually inclined,—residing within a few yards of a coast formed by such strata (of magnesian limestone); these dip towards the sea under a very gentle angle, only about 2°. The ebb consequently exposes a band of them of considerable breadth, more than a furlong; the whole of this band has been eroded by the tidal waves into a complete and most illustrative model, presenting on the small scale all the phænomena above described, escarpments overhanging expanded longitudinal depressions, transverse breaches, &c. &c. And I may add, that the tidal action very commonly does *actually* produce what Mr. Lyell, following Mr. Scrope, *fancies* can result only from fluvial action, namely, serpentine and meandering furrows often of considerable depth and length. I need not add what pleasure it would give me to see either gentleman here, and convince him of the fact by ocular demonstration. I have indeed been surprised how this argument could have been so strongly urged by two observers, to the combined acuteness and accuracy of both of whom geology is so deeply indebted: for it has ever appeared manifest to me, that even a diluvial current, supposed to be excavating the strata over which it rushes, can continue to pursue a straight inflexible line no longer than the constitution of those strata is such as

to oppose an uniform resistance to it; when any circumstance occurs which creates a variation in the resistance, such as the change from softer to harder strata, faults traversing them, and the like, a corresponding deflexion in the course of the current seems a necessary consequence.

The origin of the valleys of excavation, then, I am inclined to refer in part to the currents of the ocean in which they were first deposited, in part to those accompanying the gradual retreat of that ocean. But since we have also sufficient evidence that subsequent convulsions, such as the elevation of the Isle of Wight for instance, must have disturbed the oceanic level sufficiently to have occasioned renewed diluvial waves sweeping over tracts which had previously emerged, we have hence a third class of currents, which must undoubtedly have tended greatly to modify the results of the two former.

Do I then deny that fluvial erosion has ever produced a single valley? and if so, how do I dispose of the evidence which has been brought forward in favour of this view? I will avow the tendency of my arguments openly and frankly. I deny that all valleys of excavation have been so produced: I deny that many have been so produced: I deny that any have been so produced, except under extraordinary circumstances. And to the evidence I reply, that it relates to districts in which these extraordinary circumstances undoubtedly exist,—volcanic districts for instance, such as Auvergne and the neighbourhood of Ætna. Now I cannot admit the action of torrents occasioned by, and cooperating with, volcanic convulsions, as an example of the ordinary action of common streams;—but that under these extraordinary circumstances, and even under such more common but still comparatively rare incidents as the late floods in Scotland, fluvial action may occasionally produce considerable effects, *I* do not deny.

Art. III.—The phænomena of cataracts are inconsistent with the fluvial hypothesis.

The fluvial hypothesis requires me to believe, that since the emergence of our continents the atmospheric drainage has commonly furrowed them into valleys hundreds of miles in length, and hundreds of feet in depth;—that the streamlets forming the Thames, for instance, have done this. But if such have been the effects of these comparatively tranquil streams, what must the effects have been of a volume of water like that of Niagara precipitated in thundering fury! I here indeed take it for granted that Thames and Niagara have been acting on the surface for the same period. If this be denied, I shall certainly require a reason for that denial, and shall wish to be informed what is the exact seniority of old Father Thames

Thames over young Niagara. Meanwhile considering them as coæval, I will ask how I am to account for the mighty effects ascribed to the Thames, within a period during which the utmost effects that can be ascribed to Niagara are the gradual wearing away of the bar over which it rushes, for a distance not exceeding 7 miles; for the general range of the mountains which occasions those falls extends only that distance eastwards from their present site, when the hills entirely subside into the flats bordering Lake Ontario, and of course the original site of the falls cannot have been beyond the extreme escarpment of those hills. Mr. Lyell, taking for his datum that the falls have receded near 50 yards within the last 40 years, calculates that they must have occupied 10,000 years in retrograding from the original to the actual position, and that it will require 30,000 more for them to reach Lake Erie. But if both the actions commenced together, must it not have completed this effect ages before the Thames could have excavated even a third of its present valley? Taking Mr. Lyell's own determinations, I do not know a more striking instance of the comparatively inconsiderable power of fluvial erosion acting under circumstances that must every way give it its maximum of intensity: but I must confess my doubts whether the falls actually do recede, as far as their general line is concerned, at the rate of 50 yards in 40 years. I suspect that some partial degradation of the strata has here been mistaken for the general retrogradation. My grounds of suspicion are these: The falls are, as is well known, divided in the centre by an extremely small islet; but from the periods of our earliest accounts it should appear that this islet has occupied exactly the same relative position, with regard to the falls, that it holds at the present moment. The celebrated narrative of the Indian whose canoe drifted against this islet, whence he was subsequently so wonderfully rescued, more than a century ago, involves a full description of all the particulars of this locality, and proves it to have been then very nearly the same as at present.

Cataracts indeed appear generally to have undergone surprisingly little change from the earliest periods to which history extends. The cataracts, or rather rapids, of the Nile above Syene, when examined by the sçavans of Buonaparte's expedition, agreed pretty closely in locality, features, and extent, with the description given by the Grecian Father of History. I have always inclined to consider the cascades of Tivoli as another evidence of the slight changes effected in this way during a long series of centuries. But Mr. Lyell's remarks on this locality (although I cannot say they have changed my opinion) in every way claim an attentive examination,

nation, which I shall accordingly endeavour to give them. My argument would stand thus: All the localities of this scene still appear the same as when its beauties inspired the muses of Horace and Statius some 18 centuries ago; the fane of the sibyl, the "domus Albuneæ resonantis," still re-echoes with the dash of the fall beneath:—though did rivers travel at the rate the Fluvialists think they do, the said falls must surely have removed far beyond ear-shot of the old sibyl long ago. Mr. Lyell, however, dwells at length on the fall of a little bit of vertical cliff, 15 paces wide and a few yards long, occasioned by the floods in 1826: as if the undermining such a fragment were the same thing as the excavation of a valley of denudation. At such an event Vesta, he thinks, must have trembled in her beautiful temple for the stability of the planet over which she presides. If the turret-crowned goddess were indeed thus affected, the proximate sibyl whom I have alluded to, may, I think, well have stept in, in the neighbourly character of a comforter.

"My dear Sister,"—methinks I hear her saying,—"banish all such apprehensions; from long experience I myself can assure you they are as totally unfounded as any of the dreams with which the Clouds, the great patrons as you know of all theories of atmospheric drainage, ever inspired the Aristophanic Sophists. Many many years have I myself lived in this self-same old house; and from the first moment I came here, I have ever heard the torrent below, dash dash dash—thundering away at the very same spot: yet during the whole time it has not been able to work away enough to remove five inches yet. Believe me, according to a proverb which I understand to prevail in the island whence those wild savages come, whom, as you may remember our friend Cicero cautioned Atticus, were far too stupid to buy as slaves, ''tis all much cry and little wool.' If you are not to be shaken from your seat till this fluvial action can shake you, trust me, you may sit still long enough."

Never myself having had the pleasure of visiting this most interesting spot, I should not, however, have ventured to question the views which Mr. Lyell appears to have formed after personal examination, had I not found my own opinion of the nearly permanent position of the fall strongly confirmed by the minute descriptions of a scientific friend perfectly acquainted with the locality. The inferences drawn by this friend from the phænomena of this Classical cascade are altogether in agreement with the conclusions I am endeavouring to establish. Independently of the historical records, and all the remains of antiquity, according to his opinion, the natural phænomena of the

the spot appeared to prove that the place of the great cascade had been stationary, or nearly so, from the moment when the river commenced its course through the valley of excavation previously traced out for it by some cause far different from any action of the river itself. The circumstances of the spot are the following: The Anio above Tivoli flows gently onwards towards the edge of the precipice, through a gorge of Apennine limestone of the oolitic period. Near the entrance of Tivoli, a dyke has been constructed across it, diverting a part of its waters through an artificial tunnel on the left or southern side, and thus conducting them so as to issue in several artificial *cascatelli* out of the side of the hill below the main and only natural cascade, that of the Grotta di Nettuno. With the artificial *cascatelli* we have nothing to do, further than to observe, that one of them turns the machinery of an iron-foundry now established within the half-ruined walls of the Villa of Mæcenas (Domus antiqua heu quam dispari dominaris domino). This branch, by its relations to the domain of that great patron, shows that no change has taken place since his time along the line of its descent, from his palace to the bottom of the valley beneath, excepting the deposition of travertin; the waters of the Anio while foaming in a state of precipitation have always deposited travertin; and this travertin accumulating on the bar of limestone over which it fell, as may especially be seen at the great and only real cascade of the Grotta di Nettuno, immediately became a defence against all further erosive action of the river on the subjacent Apennine limestone. This perpetually increasing shield of travertin would probably go on accumulating more rapidly in its upper parts than the agitated state of the bottom would allow below; and hence periodical breakings away of its unsupported overgrowings would take place, as of the curling edges of drifted snow. But this failure of support would not affect the inferior sheets of travertin in immediate contact with the limestone: these once formed, will have remained from the day of their formation, arresting all further destruction of the stratified rock beneath. From the base of the cascade to the plain of Rome is about a mile; and in this mile the river descends a valley narrow at its base, and flanked on both sides by slopes of moderate inclination, most steep at the *cascatelli* on the left bank, and on the right bank nearly opposite them. Now it is observed, had this cascade been working gradually backwards through the eternity of the fluvialist theory, it must have deposited travertin all along the gorge it was forming at each successive station, which it occupied from time to time, just as it has done at its actual station the Grotta di Nettuno; every part of

of the gorge below this point should have been a precipitous ravine uniformly incrusted with travertin, such as now covers the site of the actual cascade: instead of this, we have a valley included by gentle slopes, except at its upper extremity, where its sides for a short interval become more steep; nor is there a single particle of the travertin which, on the theory, ought to have prevailed through its whole extent, except in the neighbourhood of the artificial *cascatelli*, which of course must necessarily produce it, just as the natural cascade does.

I have now concluded the cursory view which I proposed to take of the phænomena of geology bearing on theoretical points, and of the inferences which the observers of the school to which I am attached, have thought themselves justified in deducing from them. And I am now happy to leave, I hope for a long time, the field of theoretical, and especially controversial discussion. Having heartily tired myself, and I fear far more tired your readers, I can well say with the copyists of the middle ages: "Explicit, expliceat; ludere Scriptor eat."

XLVI. *On the Reduction to the Meridian.* By S. Sharpe, *Esq. F.G.S.**

IN the well-known formula for the reduction to the meridian of a zenith distance observed near to the meridian (see Baily's Tables, page 93):

x being correction required;
P hour angle;
L latitude of the place;
Δ polar distance of the body observed;
Z zenith distance of ditto;

$$\sin x = 2\sin^2\frac{P}{2}\left(\frac{\cos L \sin \Delta}{\sin Z}\right) - 2\sin^4\frac{P}{2}\left(\frac{\cos L \sin \Delta}{\sin Z}\right)^2 \cot Z.$$

When the sun or a planet is the body observed, the additional term $\pm\, \delta . P$ is usually added: δP being its change of declination, proportional to the time P.

But when this is done, the first term ought to be

$$2\sin^2\frac{P}{2}\left(\frac{\cos L \sin(\Delta + \delta P)}{\sin(Z + \delta P)}\right),$$ or, what is the same thing,

we should add a fourth term

$$\pm\; 2\sin^2\frac{P}{2}\sin(P\delta)\frac{\cos^2 L}{\sin^2 Z}\,.$$

Remembering that these two terms containing δ are to be of

* Communicated by the Author.

different

different sines when some of the observations are on one side of the meridian and some on the other.

And this new term is too important to be neglected,

1st, In low latitudes, when $\frac{\cos L}{\sin Z}$ is large.

2nd, At a distance from the meridian, when P is large.

3rd, Near the equinoxes or planet's nodes, when δ is large.

4th, When the observations are principally on one side of the meridian.

If we make

$$K = \frac{\cos L \sin \Delta}{\sin Z \sin 1''} \cdot M = \left(\frac{\cos^2 L \sin^2 \Delta \cot Z}{\sin^2 Z \sin 1''}\right) \text{ and } N = \frac{\cos^2 L}{\sin^2 Z}$$

$$x = \text{versin } P \cdot K - \left(\text{vers } P - \frac{\text{vers } 2P}{4}\right) M \pm$$

$$\left(\sin P - \frac{\sin 2P}{2}\right) \delta \cdot N \pm \delta \cdot P.$$

which is the form most easily calculated for a repeating circle, with a table of natural sines and versed sines, when Mr. Baily's convenient Tables are not at hand.

S. Sharpe.

XLVII. *Proceedings of Learned Societies.*

ANNIVERSARY OF THE GEOLOGICAL SOCIETY.

Address to the Geological Society, by the President, *the Rev.* Adam Sedgwick, *M.A. F.R.S. &c., on announcing the first award of the Wollaston Prize.* (February 18, 1831.)

Gentlemen,

BEFORE you proceed to elect the Officers and Council for the coming year, it remains for me to announce from the Chair the adjudication of the Wollaston Prize. The affecting circumstances under which it was founded, so short a time before the death of one of the most illustrious men who have adorned our lists, the earnest wishes he expressed, almost with his dying breath, for the honour and well-being of this Society, and the peculiar public interest attached to a first award, have thrown a more than usual responsibility upon the Council. We were deeply conscious of this responsibility; we have not come to our decision lightly; and in what we have done we look for your entire approbation.

I am anxious, in the first place, to recall to your recollection the powers committed to the Council, and the spirit of the instructions by which they were directed in their award; and I have no means of doing this so effectually as by quoting a portion of the communication, in which Dr. Wollaston first informed us of his intention of establishing the "Donation Fund." After stating that he had invested one thousand

thousand pounds in the three per cent. reduced bank annuities, in the joint names of himself and the Geological Society, he directed that after his decease "the Society should apply the dividends in promoting researches concerning the mineral structure of the earth, or in rewarding those by whom such researches might hereafter be made; or in such manner as should appear to the Council of the said Society for the time being, conducive to the interests of the Society in particular, or the science of geology in general," &c. And he afterwards enjoined the Society "not to hoard the dividends parsimoniously, but to expend them liberally, and, as far as might be, annually, in furthering the objects of the trust."

Such, Gentlemen, was the letter of our instructions: and as we were enjoined to expend the proceeds of the Donation Fund, as far as might be, annually; I will read an extract from the Report of the Council at the preceding Anniversary, as it will explain our motives for withholding, on that occasion, the distribution of the dividends.

"The Council have not thought it expedient to make as yet any distribution of the dividends arising from this fund, but have appropriated the first year's income to the acquisition of a die for a medal which is to bear the head of Dr. Wollaston: and they hope that the Society will approve of this endeavour to perpetuate in the minds of geologists the memory of their illustrious benefactor. The first annual distribution, therefore, of the Wollaston Medal, as well as a certain sum of money, will be awarded at the next anniversary according to the provision of the bequest."—(Feb. 19th, 1830.)

Mr. Chantrey kindly undertook to carry the resolution of the Council into effect; and under his directions Mr. Wyon of the Royal Mint was employed to execute a die, which we hope before long to see finished. We met, therefore, in the early part of this year to act upon the letter of our instructions, and we recorded our award in the following Resolutions.

Extract from the Minute-book of the Council, Jan. 11, 1831.

Resolved unanimously—1. "That a Medal of fine gold, bearing the impress of the Head of Dr. Wollaston, and not exceeding the value of ten guineas, be procured with the least possible delay."

2. "That the first Wollaston Medal be given to Mr. William Smith, in consideration of his being a great, original discoverer in English Geology; and especially for his having been the first, in this country, to discover and to teach the identification of strata, and to determine their succession by means of their imbedded fossils."

The first gold medal struck from the die now in progress will therefore be sent to Mr. Smith; and we have added to it a purse of twenty guineas, from the dividends of the "Donation Fund," which it is now my duty publicly to present to him in the name of the Geological Society. His great and original works are known to you all; and I might well refer to them for our justification, and without any further preface place the prize in his hand, offering him my hearty congratulations. But since his arrival in London, within the last few hours, he has given me a short account of his early discoveries, and has

has shown me a series of documents of no ordinary interest to this Society, and important to the correct history of European geology. I should ill perform my present task were I to withhold this information from you; I proceed therefore to communicate it with what brevity and simplicity I can.

Mr. William Smith was born at Churchill in Oxfordshire—a place abounding in fossils, the playthings of his childhood, and the objects of collection in his early youth. This is one of many instances where things, in themselves inconsiderable, act powerfully on peculiar minds, so as to influence the whole tenour of after-life. During his boyhood his habits of observation became confirmed by lessons in practical surveying: he remarked the alternations of argillaceous and stony strata, and thence became acquainted with the origin of springs and the true principles of draining; and fortunately many practical works of this kind were carried on under his immediate inspection.

In 1787 (when eighteen years of age) he was employed in surveying and inclosing extensive tracts of common-land: this gave him a further insight into the minutest modifications of structure in his native country; and within the two next years his surveys extended beyond the oolite hills into the plain of the new red sandstone. The regular stratification of the lias and the peculiarities of the red ground, at that time new to him, made a lasting impression on his mind. Carrying with him his acquired habits of accurate observation, he continued his surveys (during 1790) to the coast of Hampshire, and to the country round Salisbury and Bath; and he became gradually familiar with the outline of the chalk downs, and the external characters of large agricultural districts. In 1791, while employed in making extensive surveys in a part of Somersetshire, he remarked the identity of the red marl and lias of that county with the corresponding formations of Gloucestershire, and recognized their discordant position on the coal measures. During the same year he made several detailed sections of the coal strata; collected fossil plants which he found characteristic of particular beds in his sections; and remarked that none of the many fossils of the lias were found either in the coal strata or the red marl: and at this time he also began to make practical observations and inquiries with a view of ascertaining the range and extent of the successive deposits, and the reality of a general line of dip towards the east, of which he had already seen so many local instances.

I think these facts of great importance, as they contain the germ of all Mr. Smith's future discoveries. And we must bear in mind—that his attention was distracted by the duties of a laborious profession—that he had barely reached the age of manhood—and that he had not received a glimmering of direction in his general speculations.

In the course of the two following years, while continuing the duties of a surveyor and civil engineer, he became gradually acquainted with all the minute facts of stratification in the country round Bath: and for the purpose of bringing to the test the inquiries suggested by his surveys in 1791, he made two transverse sections along the lines of two parallel valleys intersecting the oolitic groups (determining the actual elevation of these lines by means of levels carried from the

Somerset Coal Canal); and ascertained that the several beds, found in the high escarpments around Bath, were brought down by an eastern dip, in regular succession, to the level of his lines of section. During these two years Mr. Smith was in the constant habit of making collections of fossils, with strict indications of their localities; and in completing the details of his transverse sections, he found, where the beds themselves were obscure, that he could by organic remains alone determine the true order of succession. During this period he also extended his surveys through the Cotteswold Hills, and became acquainted with the general facts of the range of the oolitic escarpment towards the North of England.

In the year 1794 he crossed the whole series of formations, and marked their escarpments between Bath and London; and afterwards extended his surveys to the Durham and Northumberland coal-field: while on his way, partly by actual sections and partly by the help of external contours, with which his eye was now familiar, he ascertained the range of the chalk to Flamborough Head, and of the oolitic series, through a regular succession of escarpments, to the Hambleton Hills and the cliffs of Yorkshire. Combining the facts discovered in this excursion with the distribution of the formations in the south-western parts of England, he began to record his observations by colouring geological maps. Several documents of this kind are now unfortunately lost: but I have been informed by Mr. Phillips (Curator of the museum of the Yorkshire Philosophical Society), that he possesses a valuable geological map, coloured by Mr. Smith in the year 1800, connecting the structure of the North of England, which at that time he had not again visited, with the structure of the South-western districts; and delineating the whole oolitic series through England, in some places very correctly, and in all with a general approach to accuracy.

Mr. Smith in 1795 became for the first time a housekeeper; and no sooner had he apartments of his own, than he turned them to account by arranging his large collection of organic fossils (the accumulations of several years) stratigraphically. I am certain, Gentlemen, that this stratigraphical collection, preceded by many years any other similar collection formed in this country: and without pretending to any exact knowledge of the history of Continental geology, I greatly doubt whether a stratigraphical collection of organic fossils, derived from a long series of formations, and specially intended to assist in identifying their subordinate strata and determining their relations, was ever made before the year 1795 in any part of Europe.

Local collections of organic remains were undoubtedly made in this country long before the time of Mr. Smith, and in the works of our older writers we may sometimes find the glimmerings of his discoveries.—Woodward formed a magnificent collection of organic remains; and he separated from the rest a series of fossils of the Hampshire coast, and was aware that many of the species were the same as those of the London clay: but this fact, and many others of like kind, were with him but sterile truths; and being led astray by his theory, he knew nothing either of the real structure of the earth, or

or of any law regulating the distribution of organic forms.—Michell was a man of great talents, and undoubtedly made out the true relations of the secondary deposits in one portion of this island: but he was, I believe, ignorant of the importance of organic remains, and did not use them as a means of identifying strata.—Lister is distinguished among the writers of the seventeenth century as the first to propose the construction of mineralogical maps, and he had some limited notions of the distribution of organic fossils, though he misunderstood both their nature and importance.

The works of these authors were, however, entirely unknown to Mr. Smith during his early life, and every step of his progress was made without any assistance from them*. But I will go further, and affirm, that had they all been known to him, they would take nothing from the substantial merit of his discoveries. Fortunately placed in a country where all our great secondary groups are brought near together, he became acquainted in early life with many of their complex relations. He saw particular species of fossils in particular groups of strata, and in no others; and giving generalization to phænomena, which men of less original minds would have regarded as merely local, he proved (so early as 1791) the continuity of certain groups of strata, by their organic remains alone, where the mineral type was wanting. He made large collections of fossils; and the moment an opportunity presented itself he arranged them all stratigraphically. Having once succeeded in identifying groups of strata by means of their fossils, he saw the whole importance of the inference—gave it its ut-

* I am anxious to do no injustice to those who preceded Mr. Smith. No part of Woodward's collection was arranged stratigraphically—Michell, who occupied the Woodwardian Chair several years, was of course intimately acquainted with every part of this collection: but I do not think he made any use of it as a means of determining the order of superposition. There is, however, one passage in his celebrated paper "On the Cause and Phænomena of Earthquakes" (Phil. Trans. vol. li. p. 587), which I am bound to notice. It is as follows: "These inequalities are sometimes so great, that the strata are bent for some small distance, even the contrary way from the general inclination of them. This often makes it difficult to trace the appearances I have been relating; which, without a general knowledge of the fossil bodies of a large tract of country, it is hardly possible to do." I am almost certain, that by the term fossil, he did not intend organic remains. In the works and catalogues of Dr. Woodward (with which of course Michell was most familiar), and in the language of naturalists of the last century, every mineral substance was designated under the general term *fossil;* and organic remains were almost always distinguished by the name of extraneous fossils, organic fossils, &c. &c. The memorandum, by which it is proved that Michell had a knowledge of the true relations of several of our secondary groups, was found by accident among the papers of Sir Joseph Banks, and published in 1810. It could not, therefore, have possibly been known to Mr. Smith during the progress of his discoveries. (See Tilloch's Philosophical Magazine, vol. xxxvi. p. 102.)

Since the Anniversary, I have looked over the paper in which Lister recommends the construction of mineral maps (Phil. Trans. vol. xiv. p. 730: 1684). It is clear that he had no correct notions on the nature of stratification; and his opinions on organic remains was, as is well known, most erroneous and unphilosophical. All these questions are discussed at considerable length, and with great ability and candour, in an article of the Edinburgh Review (vol. xxix. p. 311, &c.), now known to be from the pen of Dr. Fitton. To this article I particularly wish to refer the reader.

 most

most extension—seized upon it as the master principle of our science—by help of it disentangled the structure of a considerable part of England—and never rested from his labours till the public was fairly in possession of his principles. If these be not the advances of an original mind, I do not know where we are to find them; and I affirm with confidence, after the facts already stated, that the Council was justified in the terms of their award, and that Mr. William Smith *was* "the first, in this country, to discover and to teach the identification of strata, and to determine their succession by means of their imbedded fossils."

After the year 1795, he turned his knowledge to effect in his various employments as civil engineer. Works of drainage were carried on by him on the principles of stratification—his stratigraphical collections were continually increased—he sketched geological sections on the lines of local surveys (many of which have been since published)—and traced geological lines of demarcation upon various county maps. Of these I may mention an excellent map of Somersetshire, coloured on the scale of an inch to a mile, and publicly exhibited and explained at an annual agricultural meeting at Bath, in the year 1799; and another map (publicly exhibited at the same time, and now, I rejoice to tell you, on the table of this Society) of the country six miles round Bath; representing all the different formations, and the minute subdivisions of the oolites, distinguished as they remain in our geological maps to this day. For eight or nine years he had been steadily and resolutely advancing, but without aid, and almost without sympathy; for he was so far before the rest of our geologists, if indeed they deserved the name, that they could not even comprehend the importance of what he had done. The public exhibitions I have alluded to, and the obvious practical interest of the subject, seem, however, at length, to have roused the attention of the scientific gentlemen near Bath: and it appears to have been during the meeting of the Agricultural Society, in 1799, that he first became acquainted with the Rev. B. Richardson of Farley, an excellent naturalist and a very extensive collector of fossils; and with the Rev. J. Townsend of Pewsey, whose literary and philosophic works are well known to you all. I will not do injury to this part of my narrative, by offering any comments upon these facts, but I will read you a letter I have just received from Mr. Richardson himself.

Copy of Mr. Richardson's Letter.

Farley Rectory, near Bath,
10*th Feb.* 1831.

Sir,

I am requested to present you the particulars of my acquaintance with Mr. William Smith, well known by the appropriate appellation of Strata Smith.

At the Annual Meeting of the Bath Agricultural Society in 1799, Mr. Smith was introduced to my residence in Bath, when, on viewing my collection of fossils, he told me the beds to which they exclusively belonged, and pointed out some peculiar to each. This, by attending him

him in the fields, I soon found to be the fact, and also, that they had a general inclination to the south-east, following each other in regular succession.

With the open liberality peculiar to Mr. Smith, he wished me to communicate this to the Rev. J. Townsend of Pewsey (then in Bath), who was not less surprised at the discovery. But we were soon much more astonished by proofs of his own collecting, that whatever stratum was found in any part of England, the same remains would be found in it and no other. Mr. Townsend, who had pursued the subject 40 or 50 years, and had travelled over the greater part of civilized Europe, declared it perfectly unknown to all his acquaintance, and he believed to all the rest of the world.

In consequence of Mr. Smith's desire to make so valuable a discovery universally known, I, without reserve, gave a card of the English strata to Baron Rosencrantz, Dr. Muller of Christiana, and many others, in the year 1801.

I am happy to hear that the Geological Society proposes to pay a deserved compliment to his merits, to which I most gratefully bear a willing testimony; and am, Sir,

Most respectfully,

Yours,

The Reverend Professor Sedgwick, B. Richardson.
Trinity College, Cambridge†.

Mr. Smith's views now expanded through the influence of sympathy and the hopes of patronage (too feebly answered in the event); and under the advice of the two gentlemen I have mentioned, he began to commit his thoughts to paper, and to designate the great subdivisions of our secondary series by names, many of which have been since almost universally current, and are adopted in our Society: and there now exists, in the hand-writing of Mr. Richardson, a geological table of our successive formations, dictated by Mr. Smith in 1799, for the express purpose of serving as the foundation of a memoir, to accompany an intended geological map of England. This very curious and important document is now placed before you; and as it was the first tabular sketch of our formations, drawn up before he had, in conjunction with Mr. Richardson, finally decided upon the names by which they ought to be designated, you will remark, that the successive groups, from the coal measures to the chalk inclusive, are represented by a series of numbers, accompanied with explanatory notes, but without any proper names affixed to them.

At a great sacrifice, and great personal expense, Mr. Smith now began to extend his observations with a direct view to publication: and in 1801 he printed a very elaborate prospectus, of which I fortunately possess a copy (now on the table of the Society), containing proposals for publishing, by subscription, a work in 4to, entitled, "Accurate Delineations and Descriptions of the

† The letter being addressed to me at Cambridge during my absence, was only received a day or two before the Anniversary.

Natural Order of the various Strata that are found in different parts of England and Wales; with Practical Observations thereon." The work was to have been accompanied by "a correct map of the strata, describing the general course and width of each stratum at the surface, and accompanied by a general section, showing their proportion, dip, and direction, and referring to the map by corresponding numbers and general explanations."

The concluding paragraph of the prospectus is so remarkable, that I will extract it entire:

"To attempt a complete history of all the minutiæ of strata, would be an endless labour; for a long life devoted to such a pursuit, must be inadequate to the purpose, considering the immense variety that is to be found within this little island. But should the present Essay meet with that liberal patronage from the public which the author has reason to expect, it is his intention, in a future work, to give a particular description of the numerous animal remains and vegetable impressions found in each stratum; with an accurate detail of every characteristic mark that has led him to these discoveries."

Why his hopes of patronage were disappointed, and why his works were so long retarded, not by any want of zeal on his part, but by want of assistance from the public, it is not for me now to inquire—The fact is not, however, difficult of explanation. At the time this prospectus made its first appearance, none of the magnificent discoveries of Cuvier and Brongniart were, I believe, published *. The Geological Society of London had no existence—the branches of natural history connected with secondary geology were little cultivated, and indeed almost unknown in this country—and hence some persons perhaps doubted the reality of Mr. Smith's pretensions on a subject they had been taught to regard as empirical, and the public at large took little interest in what they did not comprehend. He suffered, therefore, as many men of genius have done before him, in his peace and in his fortune, from what in our estimation constitutes his chief honour—from outstripping the men of his own time in the progress of discovery.

The Geological Society was organized in the year 1807, and its Transactions are the true records of its labours and opinions. In the first volume of the first series, published in 1811, and composed of papers read during the four preceding years, there is one paper, and one only, containing any direct allusion to the great geological importance of organic remains. The allusion is conveyed in the following words—"To derive any information of consequence from fossil organized remains, on these subjects, it is necessary that their examination should be connected with that of the several strata in which they are found. Already have these examinations, thus carried on, taught us the following instructive facts:—that exactly similar fossils are found in distant parts of the same stratum, not only when it traverses this island,

* The first memoir with which I am acquainted, explaining the views of these two illustrious authors respecting the phænomena of the Paris basin, was published in the year 1808, in the Annales du Muséum, tom. xi. p. 307.

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but when it appears again on the opposite coast: that in strata of considerable comparative depth fossils are found, which are not discovered in any of the superincumbent beds: that some fossils, which abound in the lower, are found in diminishing numbers through several of the superincumbent, and are entirely wanting in the uppermost strata*," &c. &c.

To this passage, the author appends a note, commencing as follows:—"This mode of conducting our inquiries was *long since recommended* by Mr. W. Smith, who first noticed that certain fossils are peculiar to, and are only found lodged in, particular strata; and who first ascertained the constancy in the order of superposition, and the continuity of the strata of this island," &c. &c.

One quotation more and I have done. The Reverend J. Townsend of Pewsey, in the first volume of a work published in 1813 (entitled "The Character of Moses established for Veracity as an Historian"), described at considerable length the secondary strata of England; and after referring nearly the whole of his information to Mr. Smith, adds the following words:—"The discoveries of this skilful engineer have been of vast importance to geology, and will be of infinite value to the nation. To a strong understanding, a retentive memory, indefatigable ardour, and a more than common sagacity, this extraordinary man unites a perfect contempt for money, when compared with science. Had he kept his discoveries to himself, he might have accumulated wealth; but with unparalleled disinterestedness of mind, he scorned concealment, and made known his discoveries to every one who wished for information. It is now eleven years since he conducted the Author in his examination of the strata which are laid bare in the immediate vicinity of Bath: and subsequent excursions in the stratified and calcareous portions of our island have confirmed the information thus obtained."

Knowledge thus orally communicated, gradually and insensibly became a part of the public stock; and beyond doubt "produced a very important, though unobserved effect upon the labours of all succeeding inquirers, who have been, perhaps unconsciously, but not less really, indebted to Mr. Smith for very essential assistance in their progress."—*Edinburgh Review*, vol. xxix. p. 313.

On what Mr. Smith has done since 1813, it is needless for me to dwell, as it is now a matter of public notoriety. But I may be pardoned for reminding you of his great geological map of England, published in 1815, which forms one of the decorations of this room—of a work accompanied by plates (published by Mr. Sowerby, in numbers, commencing, I believe, in 1816), entitled "Strata identified by their Fossils"—of a stratigraphical system, published in 1817, specially designed as an accompaniment to his collection of fossils purchased by the Treasury, and deposited in the British Museum—of his instructive series of sections, published at various times, and

* Geol. Trans. vol. i. 1st series, p. 325.

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intended to illustrate his other works—lastly, of his twenty county maps, the result of incredible labour, and admirable for many of their details; and of a value known to every English geologist who has laboured in the field.

I for one can speak with gratitude of the practical lessons I have received from Mr. Smith: it was by tracking his footsteps, with his maps in my hand, through Wiltshire and the neighbouring counties, where he had trodden nearly thirty years before, that I first learnt the subdivisions of our oolitic series, and apprehended the meaning of those arbitrary and somewhat uncouth terms, which we derive from him as our master, which have long become engrafted into the conventional language of English geologists, and, through their influence, have been, in part, also adopted by the naturalists of the Continent.

After such a statement, Gentlemen, I have a right to speak boldly, and to demand your approbation of the Council's award—I could almost dare to wish, that stern lover of truth, to whose bounty we owe the "Donation Fund"—that dark eye, before the glance of which all false pretensions withered, were once more amongst us. And if it be denied us to hope, that a spirit like that of Wollaston should often be embodied on the earth, I would appeal to those intelligent men who form the strength and ornament of this Society, whether there was any place for doubt or hesitation? whether we were not compelled, by every motive which the judgment can approve, and the heart can sanction, to perform this act of filial duty, before we thought of the claims of any other man, and to place our first honour on the brow of the Father of English Geology.

If, in the pride of our present strength, we were disposed to forget our origin, our very speech would bewray us; for we use the language which he taught us in the infancy of our science. If we, by our united efforts, are chiseling the ornaments, and slowly raising up the pinnacles of one of the temples of Nature, it was he that gave the plan, and laid the foundations, and erected a portion of the solid walls, by the unassisted labour of his hands.

The men who have led the way in useful discoveries, have ever held the first place of honour in the estimation of all who, in aftertimes, have understood their works, or trodden in their steps. It is upon this abiding principle that we have acted; and in awarding our first prize to Mr. Smith, we believe that we have done honour to our own body, and are sanctioned by the highest feelings which bind societies together.

I think it a high privilege to have had the honour of filling this chair, on an occasion when we are met, not coldly to deliberate on the balance of conflicting claims; in which, after all, we might go wrong, and give the prize to one man by injustice to another; but to perform a sacred duty where there is no room for doubt or error, and to record an act of public gratitude, in which the judgment and the feelings are united.

Gentlemen,

Gentlemen, I will detain you no longer: Mr. Smith is now present, and though become grey in the service of science, you will rejoice to see that he still has the lineaments of vigorous health; and I cannot refrain, before I sit down, from expressing a fervent hope, (in which you all will join me), that God may long preserve that life he has employed so much to his own honour, and the advantage of his country."

The President then presented, in the name of the Society, a purse of twenty guineas to Mr. Smith, being a portion of the proceeds of the Wollaston Fund; and promised to forward to him the first gold medal struck from the die above mentioned. Mr. Smith, in a short and manly speech, returned thanks for the honour conferred upon him; expressed his anxiety to be still a useful servant of the public as a practical geologist; and, finally, presented to the Society some documents referred to in the President's address*.

After electing the Officers for the coming year, the Society adjourned till the evening, when the following Address was delivered:

Address to the Geological Society, delivered on the Evening of the 18*th of February* 1831, *by the Rev. Professor* Sedgwick, *M.A. F.R.S. &c. on retiring from the President's Chair.*

I congratulate you, Gentlemen, on the general Report of the Council laid before the Society this morning. The number of names on our lists has increased by 45 since our last anniversary; and after discharging all the expenses of the past year, besides paying off 835*l.* of arrears, there remains a balance of more than 450*l.* to meet the ordinary expenses of the current year. We have now a clear property amounting in value to 1200*l.*, without including in this estimate our books, cabinets, and collections. Our Library has been enriched with many valuable works, and our Museum with large suites both of English and Foreign specimens. But it is not so much to the increase of our various collections as to the great progress made in arranging them, that I rejoice to call your attention. They have received an immense accession of value from the labour bestowed on them by Mr. Lonsdale, whose zeal, self-devotion, and great talents are now well known to you all. I heartily concur in the sentiments recorded by the Committee, and am convinced that no small part of our present prosperity is derived from our official connexion with that gentleman.

As a duty imposed on me by the office I have had the honour to fill, I now proceed to throw a retrospective glance over the memoirs which have come before us during the past year. To introduce them in chronological order would be attended by no advantage, and would deprive me of the power of showing their relations to each other, and of making such general comments as are compatible with the limits of this address. I shall commence, therefore, with the memoirs relating to the older formations, and pass on to those connected with the great secondary and tertiary groups; and in this way, without mingling matters of fact and speculation, I hope to lead you to the

* [Various papers detailing the history of Mr. Smith's researches will be found in the former series of the Philosophical Magazine; in vol. xxxv. p. 113, vol. xlii. p. 249, vol. liii. p. 112; &c.—Edit.]

consideration of one or two great questions which have lately been pressed upon our attention*.

A paper by Mr. Weaver on the physical structure of the South of Ireland demands our first notice. It is accompanied with a geological map, extending to the limits of a similar map of the East of Ireland, published by him in a former volume of our Transactions; and we have thus obtained from his unassisted labours an accurate geographical distribution of the formations spread over more than half that island. But great as they are, these are not the only obligations we owe to that excellent observer. He has described with the clearest details the various formations of the South of Ireland, commencing with the contorted and highly inclined groups of the older transition rocks, and ending with the unconformable deposits of old red sandstone and carboniferous limestone.

The order of succession, as far as it goes, is in exact accordance with that of our island, and the beds of transition limestone subordinate to the greywacké contain nearly the same series of organic remains as the corresponding beds of Gloucestershire, Cumberland, and South Wales. Amidst the uncertainty of some of our conclusions derived from the organic types of deposits remote from each other, we seem in these transition fossils to have a secure starting point; and whether derived from the flanks of the Austrian Alps, the eastern plains of Gallicia, the central regions of Russia, or the greywacké chains of northern Germany or North America, they have at least a family resemblance not easily mistaken.

In the limestone of Cork Mr. Weaver observed impressions of the vertebræ of fishes associated with the fossils abounding in the greywacké slate of the neighbouring country. The fact is in perfect accord with our present knowledge. Impressions of fish have long been known of in some varieties of transition slate; certain families of crustacea are eminently characteristic of formations of the same age; remains of fish are commonly found in the mountain limestone of Bristol; shark's teeth occur in the mountain limestone of Northumberland; and I need not perhaps remind you that impressions of fish (sometimes accompanied with crustacea) are found in incredible abundance among the bituminous schists associated with the old red conglomerates of Caithness. Yet such is the inveteracy of our prejudices in favour of the hypothesis which admits nothing but what we suppose the simplest forms of animal life into the older strata, that even now we receive the facts opposed to it with doubt and hesitation.

What above all distinguishes the greywacké series of the South of Ireland from the corresponding deposits in this country, is the occurrence of beds of pyritous shale abounding in impressions of Equiseta, Calamites, &c., and containing beds of coal (whence many thousand tons are annually extracted) interlaced with, and partaking of, all the flexures of the transition system†. This fact, rendered doubly striking

* [Abstracts of the memoirs reviewed by Professor Sedgwick, in the above Address, will be found in our reports of the Proceedings of the Geological Society, Phil. Mag. and Annals, N.S. vol. vii. viii. and ix.—Edit.]

† Small quantities of anthracite have been found here and there among the old slate rocks of Cornwall; and some portions of the oldest division of the

striking by the horizontal and discordant position of the true carboniferous limestone of the neighbouring districts, was an important addition to our information, and was heard with no small surprise by many members of this Society. It gives us, however, a new term of comparison with the phænomena of distant countries. The greywacké chain of Magdeburg contains innumerable impressions of true coal plants, and some of the carboniferous deposits on the confines of Westphalia partake (like the deposits in the South of Ireland) of all the contortions of the older transition series.

On the descriptions of the old red sandstone and the carboniferous limestone I shall make no comments; but I think it right to recall your attention to some valuable details respecting the metalliferous deposits in the counties of Cork and Kerry. The copper ore of Ross Island, on the lake of Killarney, does not constitute either metalliferous beds or true veins, but is distributed in the form of branches or strings, contemporaneous, like those of calcareous spar, with the limestone rocks they traverse. At Mucruss mine, in the same neighbourhood, copper ore was obtained from a true metalliferous bed. In Kenmare the deposits of lead ore are shown to be discontinuous masses, nearly parallel in range and dip to the regular strata.

In the county of Cork the most valuable mine of copper is opened in a true vein: but the author remarks that in some parts of this county there is a very general diffusion of cupreous matter, sometimes appearing in separate particles, and sometimes in strings, veins or filaments more or less connected with each other, but not continuous, and therefore contemporaneous with the rocks to which they are subordinate. Such repositories of metals might not inaptly be termed "*veins of segregation*," as they seem to have been formed by a separation of parts during the gradual passage of the mineral masses into a solid state.

In England we have almost every variety of metalliferous deposits. Near Whitehaven in Cumberland great masses of reniform hematite alternate with red beds of mountain limestone. At Nosterfield, near Bedale, a true bed charged with sulphuret of lead alternates with the upper strata of magnesian limestone. The great *copper pipe veins* of Ecton must have been contemporaneous with the shale limestone to which they are subordinate. The great lead veins of our northern counties originated, if I mistake not, in cracks formed during the elevation of the carboniferous chain, before the period of the new red sandstone.

In Cornwall we have, as is well known, both on the great scale and the small, every modification of veined structure. Tin is distributed through some of the granitoid rocks where no vein is visible. The slate rocks, near their junction with the granite, are traversed by veins of injection, and some of these are metalliferous, (for example,

the slate series of Cumberland are so carbonaceous as to have given rise to borings and other works in search of coal. I have been informed that similar unsuccessful attempts were formerly made in North Devon. But in none of these instances, I believe, were true coal beds and plants, like those described by Mr. Weaver, ever discovered.

an elvan or porphyry dyke near St. Austell). The regular metalliferous *lodes* were probably once but cracks and fissures produced during some periods of elevation; and how they have been filled up is perhaps a question beyond our scrutiny. But after the important experiments of Mr. Fox, there can, I think, be no doubt that the great vertical dykes of metallic ore, which rake through so many portions of the county, owe their existence, at least in part, to some grand development of electro-chemical power.

In all the crystalline granitoid rocks of Cornwall there are also many masses and "*veins of segregation*." Such are the great contemporaneous masses and veins of schorl rock; and some of these are metalliferous. The decomposing granite of St. Austell Moor is traversed, and sometimes entirely superseded, by innumerable veins of this description. Upon these lines of schorl rock there is often aggregated a certain quantity of oxide of tin, which sometimes diffuses itself laterally into the substance of the contiguous granite. After examining this district with Professor Whewell during the summer of 1828, we left it in the conviction that several of the neighbouring tin works were opened not upon true *lodes*, but upon "*veins of segregation*." I only throw out these remarks as hints for future inquiry; as the subjects introduced by the memoir of Mr. Weaver are of vast importance, and have been unfortunately but seldom brought under the consideration of this Society.

A paper by Mr. Alfred Thomas gives us some new details connected with the structure of the northern parts of Pembrokeshire. His descriptions are illustrated by a geological map, and a section extending north and south from Cardigan to St. Gowan's Head. By help of this section we are conducted, in a descending order, from the higher part of the coal series with subordinate beds of anthracite, through the mountain limestone, the old red sandstone and conglomerates, and the transition limestone with Trilobites, down to greywacké and greywacké slate. All these formations are occasionally traversed by masses of trap producing contortions and changes of structure among the rocks with which they are in contact.

In a communication read very recently to the Society, I have endeavoured to explain the structure of the Lake Mountains and the period of their first elevation—the manner in which, during a subsequent period of elevation, they were separated from the great calcareous chain of the north—and the relations they still bear to it through the intervention of a carboniferous zone. In conformity with the system first published by Mr. Otley of Keswick, I have shown that the greater part of the central region of the Lake Mountains is occupied by three distinct groups of stratified rocks of a slaty texture: and I have further shown, that crystalline unstratified masses form the true mineralogical centres of these great groups—that by the protrusion of these masses the schistose formations have been elevated into the positions they now occupy—and that a true mineralogical axis may be traced through the oldest division of the slate rocks, on each side of which the several formations, as far as they are developed, are arranged symmetrically. I have traced in great detail the range of a

band

band of transition limestone imbedded in the upper portion of these older formations: and from the phænomena described, certain facts (important in the physical history of the mountain groups) become securely established.

1. Great cracks were formed at a very ancient epoch, and probably during the first period of elevation, diverging from the central regions of the Lake Mountains; and such enormous shifts took place in the position of the shattered strata, that in several instances the broken ends of the same bed are more than a mile apart, the distance being measured in a direction at right angles to the lines of bearing. In after periods many of the existing valleys were scooped out upon the lines of fracture.

2. The central schistose groups abut in succession against the carboniferous zone; and from this fact alone (independently of many others bearing upon the same point), the two systems are proved to be unconformable.

3. The mean bearing of the great central groups, notwithstanding their enormous dislocations, is, with very slight deviations, north-east by east, and south-west by west. Now this is nearly the mean bearing of the slate rocks of Cornwall, of the principal greywacké chains of Wales and of the Isle of Man, and also of the entire greywacké chain extending across the South of Scotland, from St. Abbs Head to the Mull of Galloway: and it is, I believe, generally allowed, that these several chains, producing so great an impress on the physical character of our island, are all nearly of one age, and were probably all elevated nearly at the same period, before the complete development of the old red sandstone. Such a parallelism cannot surely be regarded as accidental, and offers, if I mistake not, a beautiful confirmation of the great principle in the late Essay of M. Elie de Beaumont, that mountain chains elevated at the same period of time have a general parallelism in the bearing of their component strata. In admitting such a principle, we must not however shut our eyes to the exceptions. Mr. Weaver has shown, that the mean bearing of the greywacké strata in the South of Ireland is east and west; and from his descriptions they appear to have been elevated before the deposit of the old red sandstone. The transition rocks of Devonshire and of a small portion of South Wales are nearly in the same direction, and parallel to the principal axis of the great Welsh coalfield.

I will not detain you, Gentlemen, with my speculations on the original extent of our carboniferous formations—on the different periods of elevation of the coal-fields on the Bristol Channel and of the great carboniferous chain of the North of England—on the different effects produced by the two systems on the range of the newer secondary groups—or on the causes by which the conflicting phænomena have been brought about.—I may however be permitted to remind you of the prevailing north and south bearings of the great carboniferous chain, from the latitude of Derby to the border of Scotland—of the great faults by which its western limits are tracked through the Peak of Derbyshire—of its prolongation through an anticlinal line into the high

high western moors of Yorkshire—and of the enormous breaks accompanying its escarpment from the heart of Craven to the foot of Stainmoor. The range and effects of one part of the great Craven fault have been described, with excellent illustrative sections, by Mr. Phillips of York. Taking the subject up where he had left it, I have traced a connected system of breaks to the foot of Stainmoor, and shown that by a prolongation of the great Craven fault, producing an enormous downcast on its western side, the entire carboniferous zone of the Lake Mountains has been nearly cut off from the central chain with which it must undoubtedly have been once continuous.

Another enormous break, passing under the escarpment of the Cross Fell range, meets the prolonged line of the Craven fault near the foot of Stainmoor. The forces producing this double system of disruptions appear to have been contemporaneous, and by their joint action have thrown whole mountain masses of the carboniferous series headlong into the valley of the Eden.

We have direct proof that all the fractures above mentioned took place immediately before the formation of the conglomerates of the new red sandstone; and we have the strongest reasons for believing, that they were produced by an action both violent and of short duration: for we pass at once from the inclined and disrupted masses to the horizontal conglomerates now resting upon them; and there is no trace of any effect that indicates a slow progress from one system of things to the other.

Lastly, we have the clearest evidence to show that these vast disruptions were produced during the elevation of the carboniferous chain; and, if I am not mistaken, during the same period arose many minor cracks and fissures, forming the moulds into which were, in after times, cast some of the richest lead veins of our island.

It is well known that the rich carboniferous deposits of this country undergo a great change of structure in their range from the Bristol Channel to the valley of the Tweed; and I hope I shall not be thought to wander too far from my object, if I attempt shortly to explain in what the changes consist, and what are their modifications.

All our coal formations are essentially composed of mountain limestone, sandstone, and shale: they differ only in the mode in which these constituents are aggregated—In the various coal-basins on the Bristol Channel, the limestone-beds are developed only in the lower, and the coal-bearing-beds in the upper part of the series; and the two members are separated by nearly unproductive deposits of millstone-grit and shale.

Almost in the same words we may describe the carboniferous series of Derbyshire. There, however, the millstone-grit is more complex, and of very great thickness; and subordinate to the great shale are, here and there, very thick masses of a peculiar, thin-bedded and somewhat argillaceous limestone.

On the re-appearance of the carboniferous limestone, at the base of the Yorkshire chain, we still find the same general analogies of structure: enormous masses of limestone form the lowest part, and the rich coal-fields the highest part of the whole series; and, as in the

the former instances, we also find the millstone-grit occupying an intermediate position. The millstone-grit, however, becomes a very complex deposit, with several subordinate beds of coal; and is separated from the great inferior calcareous group (known in the North of England by the name of *scar lime-stone*), not merely by the great shale and shale-limestone, as in Derbyshire, but by a still more complex deposit, in some places not less than 1000 feet thick; in which five groups of limestone strata, extraordinary for their perfect continuity and unvarying thickness, alternate with great masses of sandstone and shale, containing innumerable impressions of coal plants, and three or four thin beds of good coal extensively worked for domestic use.

In the range of the carboniferous chain from Stainmoor, through the ridge of Cross Fell, to the confines of Northumberland, we have a repetition of the same general phænomena. On its eastern flanks, and superior to all its component groups, is the rich coal-field of Durham. Under the coal-field, we have, in regular descending order, the millstone-grit, the alternations of limestone and coal measures nearly identical with those of the Yorkshire chain, and at the base of all is the system of the great *scar limestone*. The *scar limestone* begins, however, to be subdivided by thick masses of sandstone and carbonaceous shale, of which we had hardly a trace in Yorkshire; and gradually passes into a complex deposit, not distinguishable from the next superior division of the series. Along with this gradual change is a greater development of the inferior coal-beds alternating with the limestone; some of which, on the north-eastern skirts of Cumberland, are three or four feet in thickness, and are now worked for domestic use, with all the accompaniments of rail-roads and steam-engines.

The alternating beds of sandstone and shale expand more and more, as we advance towards the North, at the expense of all the calcareous groups, which gradually thin off, and cease to produce any impress on the features of the country. And thus it is, that the lowest portion of the whole carboniferous system, from Bewcastle Forest along the skirts of Cheviot Hills to the valley of the Tweed, has hardly a single feature in common with the inferior part of the Yorkshire chain; but, on the contrary, has all the most ordinary external characters of a coal formation. Corresponding to this change, is also a gradual thickening of carbonaceous matter in some of the lower groups. Many coal works have been opened upon this line; and near the right bank of the Tweed (almost on a parallel with the great *scar limestone*) is a coalfield, with five or six good seams, some of which are worked, not merely for the use of the neighbouring districts, but also for the supply of this capital.

The beds of sandstone, shale, and limestone, forming the base of the carboniferous system in the basin of the Tweed, are often deeply tinged with red oxide of iron, and have been sometimes compared with the new, and sometimes with the old red sandstone. To the new red sandstone they have unquestionably no relations; and I should rather compare them (especially as the old red sandstone of the

the North of England seldom exists but as a conglomerate, and is seen in that form on the flanks of the Cheviot Hills) with the red beds of mountain-limestone and sandstone, which, both in Cumberland and Lancashire, sometimes form the base of the whole carboniferous series.

Such are the remarkable changes of our carboniferous system in its range from the Bristol Channel to the Scotch border: and it reappears on the north-side of the great greywacké chain of that country with so many points of analogy, that we must, I think, regard the coal measures in the neighbourhood of Edinburgh as part of a very ancient deposit, nearly of the same age with that on the banks of the Tweed*.

Thus it appears, from what has been stated above—that tree ferns, gigantic equiseta, and other plants belonging to the herbarium of the ancient coal-fields, grew on the land, and were sometimes swept down into the sea, before the elevation of the greywacké chains of one portion of the British Isles—that in after times, the same families of plants were swept down into the sea, in immense abundance, and spread out, here and there, in beds alternating with mud, sand, and banks of zoophytes and sea-shells, during the whole period of the deposit of mountain-limestone, from its beginning to its end—lastly, that these mechanical accumulations continued to go on in shallow seas and estuaries (and perhaps also in inland lakes), till the whole process of degradation was interrupted by the elevation of the carboniferous chain, producing the enormous breaks and dislocations above described, and succeeded by the conglomerates of the new red sandstone.

Before I leave this subject, I may notice a work, just published by Mr. Witham of Edinburgh, containing many beautiful illustrations of the internal structure of fossil plants derived from the old coal-fields of the Tweed, and from various parts of Scotland. By submitting extremely thin, polished slices of these fossils to microscopic observation, he has been enabled to detect the minutest traces of organic texture; and he has proved the existence of so large a number of phanerogamic plants, in the lowest part of the carboniferous series, as greatly to modify one of the positions laid down in the Prodromus of M. Adolphe Brongniart.

A paper, by Dr. Buckland and Mr. de la Beche, on the Geology of Weymouth and the adjacent parts of the coast of Dorsetshire, brought before us all the secondary deposits of this island, from the lower division of the oolites to the chalk. It is so rich in its details, and adorned with such admirable illustrations, that the structure of the whole region, though crowded with formations, dislocated, contorted, and traversed

* The general relations of the various groups of the carboniferous system of Northumberland, are, on the whole, very faithfully represented in the geological map of that county, published some years since by Mr. Smith. A very detailed description of a portion of the carboniferous series of the Tweed was read during the past year, by Mr. Winch, before the Philosophical Society of Newcastle, and has been since published. [See our present volume, p. 11.—Edit.] Another paper, on the same subject (which I did not see till these sheets were passing through the press), has been recently published by Mr. Witham of Edinburgh.

traversed by enormous and complicated faults, will hereafter be comprehended at a single glance; and the country will be visited as classic ground, where the most perfect types of newer secondary groups may be studied under every variety of position and combination. Without attempting to follow the authors in their description of twelve of these successive groups, I may be permitted to remind you of the extraordinary bed between the Purbeck and Portland formations (first noticed by Mr. Webster), containing silicified trunks of coniferous trees and stems of cycadeoideæ. From this paper, we learn, that these trunks lie partly sunk in black earth, like fallen trees in a peat-bog, and partly imbedded in the incumbent limestone; and that many of the stumps remain erect, with their roots in the black soil, and their upper portions in the limestone: and from these facts the authors conclude—that the surface of the Portland rock was once dry land—and that on it grew a forest containing plants of a tropical form—that this forest was submerged under the waters of an estuary or a lake, but with a movement so gentle, that neither the plants nor the soil were swept away—that upon this ancient forest were accumulated the mixed formations of the Wealds, not much less than 1000 feet in thickness—and lastly, that the whole region was again sunk under the waters of a deep ocean, in which were deposited the great formations of green-sand and chalk. Continuing in the same spirit of induction, we might add—that these marine deposits again became dry land, upon which lived great tribes of palæotherian animals, now become extinct—that during this period were formed the lacustrine rocks of Hampshire and of the Isle of Wight—that it was succeeded by a sudden and violent convulsion, heaving on their edges the great deposits of the Isles of Wight and Purbeck, and at the same time producing the anticlinal axis and great longitudinal fractures, so well described in this memoir.

There can be no doubt that the same cause which upset the Isle of Wight, also produced the great breaks and fissures of the Weymouth district; and that this upheaving force (for such we must consider it) came into action at a recent geological period, is proved by the verticality of the lower lacustrine beds at the east end of the Isle of Wight. Whether this period was contemporaneous with the last elevation of the Eastern Alps may well admit of doubt: to substantiate a fact like this, many links are yet wanting in the chain of evidence; and England has, if I mistake not, been acted upon by far too many local disturbing forces, to be ever brought rigidly within the systems of the great European chains considered in the researches of M. Elie de Beaumont.

The investigation of the faults and dislocations interrupting the continuity of our secondary deposits is becoming, daily, a subject of increasing importance; and we are now called upon, not to regard them as solitary phænomena, but to trace them through whole regions, and to examine their relations to each other. These great

great theoretical and practical questions throw no common difficulties in the way of a person who is beginning the study of Geology: and it is especially on this account, that I regard the "Sections and Views illustrative of Geological Phænomena," recently published by Mr. de la Beche, as a compendium, excellently fitted to assist the progress of our science.

Before finally quitting the subject of British secondary formations, I must mention a communication by Mr. Sharpe, describing a specimen of an Ichthyosaurus found in the lias near Stratford-upon-Avon. From the proportions of the vertebræ, the size of the paddle, and the circular or oval form of its component bones, as well as from other anatomical peculiarities, the author concludes, that this animal belongs to a new species, for which he proposes the name of *Ichthyosaurus grandipes.*

Facts illustrating the structure of distant regions of the earth have their value greatly enhanced by the difficulty of obtaining them. Every gleaning of information on the physical history of Australia or the Isles of the Pacific, will be received in this Society with the deepest interest. I will not, however, detain you with any analysis of the paper by Mr. Cunningham on the Geology of Hunter's River in New South Wales, and that by Mr. Caldcleugh on the Physical Structure of the Island of Juan Fernandez, as the important parts of their contents must be still fresh in your recollection, and they offer no materials from which I can draw any general, theoretical conclusions.

Connected with the primary and secondary formations of Continental Europe, several communications have come before the Society. Of these I must first notice two short memoirs, accompanying geological maps of Moravia and Transylvania, by Doctor Boué; and a longer and more elaborate memoir, by the same author, explanatory of a geological map of Austria and Southern Bavaria. I need not inform the gentlemen whom I am addressing—that this indefatigable observer has spent many years of his life in disentangling the complex phænomena of the Alps—that he has extended his surveys through Moravia, and the great Carpathian chain to the province of Transylvania—that combining his own observations with those of De Lill, Beudant, and others, who had in part preceded him, he has been enabled to exhibit the geological relations of this vast region, and through the intervention of common deposits to bring it into accordance with the system of the Austrian Alps. It is obviously impossible for me to offer any analysis of such labours, of which the three maps presented to the Society are most honourable records.

It would be equally impossible to give, with any effect, an abstract of the several memoirs of Dr. Boué; for they bring before us so many facts, and in so condensed a form, that they seem to contain materials hereafter to be expanded into works far beyond the limits of any ordinary communication. On these subjects I must therefore be content to refer you to the printed analysis of his papers, and to his

various essays, published during the past year, on the structure of the Alpine and Carpathian chains*.

In elucidation of the geology of the Eastern Alps, a paper was also presented to the Society, during the past year, by Mr. Murchison and myself. Our object was, by help of a transverse section along the line where we crossed the Chain, to bring together such facts as were seen by ourselves, and appeared of any real importance : and, connecting them with other facts, partly derived from oral information, and partly from a number of scattered memoirs little known in this country, to give such an outline of the general structure of the whole chain, as should be intelligible to an English reader.

As our Memoir has been published, I should hardly have alluded to it, had not our views been partially misrepresented ; and, what is of vastly more importance, had we not differed from Dr. Boué in the interpretation of some very singular, and we think not unimportant, phænomena.

During the past year, Mr. Murchison again visited the same region; and the results of his investigations have been laid before us in an elaborate paper, which I am now called upon to notice. In doing this I am compelled so far to retrace my own steps as to bring to your recollection the geological subdivisions of the Alpine chain adopted in our published Memoir. We stated that the Eastern Alps, considered in their greatest simplicity, might be described as a mountain chain with an axis of primary rocks, flanked and surmounted by two great secondary calcareous zones, which are in their turn surmounted by vast tertiary deposits, descending on one side into the plains of Italy, and on the other into the plains of the upper Danube ; and that the same great physical region, when considered in more detail, might be separated into formations admitting of a general comparison with those of our own country in the following order, commencing with the lowest. 1. Primary rocks of the central axis. 2. Highly crystalline deposits graduating in the ascending order into rocks conforming to the ordinary transition type, and containing, though very rarely, transition fossils. 3. Red and variegated sandstone and gypseous marls, sometimes alternating with masses of magnesian limestone. 4. Older Alpine limestone—a formation of enormous thickness, supposed to represent a part of the oolitic series, and based upon fetid dark-coloured limestone and other strata which we endeavoured to identify with the lias. 5. Limestone and sandstone with great masses of saliferous marls rolled up and encased among the contorted strata. 6. Younger Alpine limestone, including all the secondary deposits of the Alps superior to the saliferous system, and containing two distinct groups ; the first of which was supposed to represent the highest portion of our oolitic series, and the second (or Vienna sandstone) the whole system of the green-sand and chalk. 7. Tertiary deposits.

Between the two subordinate groups of No. 6. we were not able to draw any precise line of separation ; and, to our surprise, we were still

* See especially several elaborate articles on these subjects, published by Dr. Boué, during the past year, in the *Journal de Géologie.*

still less able to define the limits of the secondary and tertiary series. For, sometimes resting unconformably among the serrated peaks of the higher mountains, and sometimes in a position intermediate between the outer zone of the chain and the tertiary plains descending towards the Danube, we found great complex deposits, apparently graduating at one extremity into the secondary, and at the other into the tertiary system, and abounding in fossils, which in a great majority of the species seemed to conform to the tertiary type. Upon this mixed evidence we concluded that these singular deposits formed a true connecting link between the secondary and tertiary systems of the region; and, though unknown in our own country and the North of France, were to be placed somewhere between the *calcaire grossier* and the chalk.

To the clearing up of this point (on which alone we had any essential disagreement with Dr. Boué), Mr. Murchison has devoted the most elaborate details of his recent Memoir. He first describes the extension of the primary axis into the Leitha-gebirge, which thus seems to form a connecting link between the Alpine and Hungarian chains, and notices some new and interesting localities of the magnesian limestone and red marl series. He then traces the reappearance of the gypseous and saliferous marls, apparently of the age of the new red sandstone, in some longitudinal valleys of the Salzburg Alps; and by means of detailed sections, fixes the great salt deposits of Aussee and Halstadt between the older Alpine limestone based upon lias, and the newer limestone terminating in the Hippurite rock. He afterwards gives various sections of the Vienna sandstone group, and shows that it is the equivalent of the green-sand and chalk; and proves, by very elaborate details, chiefly derived from the banks of the Traun, that in the enormous development of the nummulite series one part graduates into the secondary, and another into the tertiary system of the Eastern Alps; thus confirming by new and uninterrupted sections the justness of our former classification.

Among the novel and important observations in this Memoir, the author describes a deposit, at Ortenburg in the valley of the Danube, composed of chalk with flints, supporting tertiary sands and clays, and resting horizontally upon the primary rocks of the Bohemian chain. Arguing from this fact he shows, (agreeably to the system of M. Elie de Beaumont,) that the elevation of the Alpine and Bohemian chains took place at two distinct periods.

In glancing over the various papers on the structure of the Eastern Alps, it was impossible for me entirely to separate the descriptions of the older and newer systems; but I now proceed to notice some communications almost exclusively devoted to the phænomena of tertiary deposits.

A paper was laid before the Society by Mr. Murchison and myself, during the past year, on the Tertiary Formations of Lower Styria. In an east and west section, from the Styrian Alps to the confines of Hungary, we describe a long succession of marine strata; commencing, as we have endeavoured to prove by the imbedded fossils, with rocks of

of the Palæotherian period, and ascending through the middle Sub-Apennine system to a large group of strata, apparently containing several species of recent shells, and of the same age with the higher deposits of the Vienna basin. Yet in this most recent group are masses of limestone exhibiting so fine an oolitic structure, that by hand specimens alone we should find it no easy task to separate them from the great oolite of Bath.

In another section from north to south, we have shown the association of the upper tertiary groups with the rugged volcanic rocks which start out from the eastern plains of Styria: and from all the complicated phænomena we conclude, that the volcanic forces were first called into action in this region during the most recent tertiary period, and were probably continued for a long succession of ages, during which the sea was spread over the lower portions of Styria and Hungary; and that no test can be established whereby we can fix the ages of the different igneous productions: inasmuch as the same groups of strata are in one place covered by basaltic lava, in another by trachyte, in a third by volcanic conglomerate, and in a fourth alternate with volcanic sand and breccia. Lastly, we have in the discontinuous masses of volcanic breccia, and in the rude and interrupted escarpments of trachytic and basaltic rocks, the clearest and most emphatic proofs of enormous degradation, within a period of time bounded by one of the newest regular formations of geology.

Before quitting this subject, I may add that Mr. Murchison has, in his last Memoir, identified all the groups of the Vienna basin with those of our Styrian sections. The inferior blue marl (or *Tegel*) of that basin is supposed to be the equivalent of the London clay; the white coralline limestone of the Leitha-gebirge is placed on the same parallel with the limestone of Wildon; and the higher accumulations of sand and gravel are compared with the upper formations of Lower Styria, through which, as stated above, the basaltic and trachytic eruptions have made their way.

The papers of Colonel Silvertop, on two lacustrine deposits in the province of Granada, placed before us an interesting sketch of the structure of a region little known to the geologists of this country. After pointing out the primary formations of the Sierra Nevada, and the recent marine strata near the southern base of the chain, he describes the large freshwater basins of Baza and Alhama, occupying two deep depressions on its northern declivity. The strata of the former basin are subdivided into two great groups; the lower composed of marls with many fossils of the genus Cypris, and containing brine springs, gypsum, and sulphur; the upper composed of light-coloured indurated marl and limestone, charged with innumerable Paludinæ. The basin of Alhama gives very nearly a repetition of the same phænomena: but among its indurated white marls is a larger number of organic remains, some of which very nearly resemble those of the freshwater limestone in the basins of Paris and the Isle of Wight.

It is not necessary for me to point out the importance of facts like these; and I am not called upon to follow the author through his details, as his communications are already published.

On

On the subject of tertiary deposits, I have finally to notice a communication by Mr. Pratt, who found, during last summer, in the lower freshwater marls of Binstead in the Isle of Wight, many comminuted or rolled fragments of the bones and teeth of several species of Mammalia, mingled with pulverized shells, and with the bones of two or three species of freshwater turtles, resembling those described by M. Cuvier from the Paris basin. Among the more perfect specimens of these fossils, the author found a tooth of the *Anoplotherium commune,* and the teeth of two species of *Palæotheria;* thus confirming a previous discovery made known by Mr. Allen, and perfecting the zoological analogy between the newer lacustrine formations of England and central France.

The bones of the Binstead marls do not however belong exclusively to the order of *Pachydermata;* for the author also found the jaws of a ruminating animal closely allied to the genus *Moschus,* but at the same time differing in some essential characters from every species hitherto described; and he gives us reason for sanguine hope, that large additions may be hereafter made to his very important list of new fossil quadrupeds. All the magnificent generalizations of Cuvier, as far as they are borne out by the zoological phænomena of the Paris basin, apply therefore literally to the more recent physical revolutions of our own country.

Among the papers published in the early volumes of our Transactions, none excited a greater or more deserved interest than those of Mr. Webster. But first generalizations are almost always pushed too far. After being bewildered with the observation of unconnected facts, the first glimmering of general truth is so delightful, that it often leads us beyond the bounds of fair induction. We are then compelled to retrace our steps, and cast about for new phænomena; and it is only after a succession of trials and adjustments, that the facts we had at first partially misinterpreted are seen at their proper level, and with their true bearing upon each other. The broad conclusions of Mr. Webster, in his comparison of the basins of Paris and the Isle of Wight, are however too firmly established to be ever shaken; and it is only in his estimate of the subordinate groups that his early essays require either revision or correction: and surely it is no reproach to him that he did not foresee the subsequent discoveries of MM. Cuvier and Brongniart.

The *argile plastique* of Paris is now regarded as a mere local lacustrine deposit. The *plastic clay* of this country is, on the contrary, an arenaceous formation of enormous thickness, not merely coextensive with, but often stretching far beyond the limits of, our tertiary basins; and containing, here and there, subordinate argillaceous beds, and many marine shells of the same species with the characteristic fossils of the London clay.

The deposits of the Isle of Wight above the London clay are subdivided (in all our published works) into three principal groups,—the upper and the lower composed of calcareous lacustrine marls in different states of induration—the middle one of argillaceous marls supposed to be exclusively of marine origin. But it has been long known to many of the gentlemen I am now addressing, and to no one better than

than Mr. Webster—that in Headdon Hill (which gave the types of all his formations above the London clay), the middle argillaceous group contains innumerable freshwater shells, greatly predominating over the marine, and bands of lacustrine marl differing in no respect from that of the upper and lower groups—that in Norton Cliff (about two miles north of Headdon Hill), the three groups are mineralogically well developed without containing a single marine fossil—that at Hampstead Cliff, where the argillaceous marls have four or five times their average thickness, no undoubted marine shells appear on the true parallel of the *upper marine formation* *—and that in many other parts of the Isle of Wight the three groups admit not either of mineralogical or zoological separation from each other; but are composed, from top to bottom, of an indefinite number of alternations of argillaceous and calcareous marls, passing at one extremity into soft unctuous clay, and at the other into freshwater limestone †.

Facts like these prove, if I mistake not, the impossibility of instituting any rigid comparison between all the successive groups in the basins of Paris and the Isle of Wight. But discrepancies in minute details militate in no respect against Mr. Webster's leading generalizations, which have received such a striking and unlooked-for illustration in the fossil mammalia of Binstead. If the hints now thrown out should induce him to lay before the public some part of his valuable observations on our different tertiary deposits, or to hasten the publication of his long-promised work on the Isle of Wight, my present purpose will be completely answered.

In the papers a brief analysis of which I have now placed before you, we have some new and striking proofs of the great importance of organic remains in determining the comparative age of remote and discontinuous formations. And we have seen that in cases where we have few examples of specific agreement, we can, from the aspect of large groups of fossils and the general resemblance of their generic types, form at least a probable estimate of the age of the deposits to which they are subordinate. Inferences of this kind would be altogether worthless were they invalidated by the direct evidence of geological sections. But we deny that this is in any respect the case; and our conclusions are the more certain, because they are not only founded upon a wide induction of particulars, but are consistent among themselves.

There can be no doubt that in the ancient ocean, as well as in the present, the distribution of organized beings was affected by many causes—by the temperature and depth of the waters—by the nature of the soundings—by the action of tidal currents—and by other unap-

* In the highest part of the argillaceous marls of Hampstead Cliff (about two miles east of Yarmouth), there are, however, two species of Corbulæ; but they occur, if I mistake not, far above the parallel of the "*upper marine marls*" of Headdon Hill.

† Anomalies, similar to those pointed out above, are stated also to occur in portions of the Paris basin, and may perhaps hereafter be used as terms of comparison with the structure of the Isle of Wight.

preciable

preciable disturbing forces. Even among the old secondary groups we can sometimes separate littoral formations from those of deep seas, not merely by their mineral structure, but also by their fossils: and in all geological periods of the history of the earth, formations on the shores and formations in deep seas must have gone on together.

Again, our great formations may be subdivided into many distinct mineralogical groups of strata; and the large suites of organic remains, characteristic of the formations as a whole, may also be subdivided into many groups, the species being defined by the mineral structure of the beds to which they are subordinate.

All this is in harmony with the distribution of the animal kingdom in the existing seas. Some animals may be found almost indifferently on a calcareous, a sandy, or a muddy bottom (for example, the floating cephalopodes); and the remains of ancient animals of kindred organization occur indifferently in calcareous, siliceous, and argillaceous groups of strata. Some animals have lived and propagated under the waters of a muddy shore; the remains of these occur abundantly in our secondary beds of shale. To the very existence of some shells calcareous rocks are necessary; and on banks of mud or moveable sand, corals and attached zoophytes could find no proper resting place. Hence it is that many species of shells and zoophytes are chiefly characteristic of limestone strata; and if they exist at all in other beds, have probably been drifted there by the action of marine currents.

It follows from these remarks, that any great change in the mineralogical character of a formation must also be accompanied with a corresponding change in the accompanying forms of organic structure once subservient to life. In this way we may explain the great difference between the organic remains of the lower oolitic series of western and central England, and of the contemporaneous coal formation on the Yorkshire coast. And in the same way we may also explain an opposite fact, observed more than once by Mr. Murchison and myself during our traverses through the Eastern Alps, that wherever a secondary deposit of that great chain approaches the mineral type with which we are familiar in this country, it also contains an imbedded group of organic remains very nearly resembling those we have been taught to regard as characteristic of the formation.

I believe that the subject to which I am now pointing is one of interest and importance; and I know no one who could do so much justice to it as Mr. Lonsdale, whose admirable knowledge of recent and fossil species, and of the minutest subdivisions of our secondary groups of strata, (strengthened and improved as it is by the performance of the great task he has undertaken so much to the advantage of this Society,) qualifies him to compose an essay which will throw the greatest light upon the physical causes affecting the distribution of organized beings during the long periods of geology.

In a paper by Mr. Yates, the last I have to notice in connection with our ordinary subjects of discussion, we have a minute detail both of the processes regulating the production of alluvial matter, and

and of the forms it assumes during its accumulation. He first considers the causes of disintegration, independent of the immediate action of running water; among which he principally enumerates earthquakes, landslips, the various effect of oxidation, and the expansive powers of frost. He then describes the distribution of the comminuted materials by running water, the manner in which they become piled into obtuse cones in passing from lateral to principal valleys, and the various causes modifying the erosive power of rivers. From these subjects he proceeds to the forms assumed by alluvial silt when carried down into standing water, the manner in which lakes become gradually filled up, and the inclination of the stratified masses resulting from the operation. Lastly, he describes the effects produced at the junction of two streams, the depositions on the intermediate stagnant points, and the forms of alluvial masses, whether in rivers or lakes, produced by this compound action; and, from the observation of these forms, he draws some practical conclusions respecting the probable accumulations at the bottom of the sea by the opposition or the union of currents, whether flowing at the same or at different levels.

Questions of this kind are of most obvious importance; but they admit of no illustration except by details ill fitted for the nature of this address. I may however, before I finally quit this subject, remind you of two opposite facts recorded in papers very lately read in this Society, especially as they strengthen an opinion advanced at our last anniversary—that the river drainage of every physical region is a complex result, always modified by local conditions, and often depending upon the action of many successive causes. I have already shown that in a part of Cumberland and Westmorland the valleys are excavated upon the lines of ancient breaks or fissures. On the contrary, in the neighbouring carboniferous chain of Yorkshire, the faults and dislocations hardly ever range in the directions of the valleys, and do not seem to have produced any sensible effect upon the directions of the erosive currents.

Again, the valleys of the carboniferous chain are of great depth, and the strata on their opposite sides are generally horizontal and at the same level; yet within these valleys we have in every river and every tributary torrent, proofs, in my opinion the most unequivocal, that the channels where the waters now flow have only existed during a very recent period.

I mention these facts for the purpose of urging upon you the important truths, that geology has little to do with the combinations of simple elements, and that we are in most cases called upon sternly to reject such conclusions as are founded only upon particular phænomena.

Such, Gentlemen, are the subjects which have come before us during the past year. They are neither small in number nor unimportant in their objects; and whatever may be their other merits, they at least prove that our body has manifested the activity of healthy life. As we advance on our way, we gain strength at

every step; but new and loftier subjects of contemplation are continually rising up before us; so that as yet we have no glimpse of the furthest boundary to our prospects and our labours. And in all this there is a perpetual motive for combination and energy and hope, and for the exercise of all those faculties which are called forth in the great journey of discovery.

We have indeed neither the time nor the power to slumber; and, in spite of ourselves, we cannot but partake of that forward movement by which all our neighbours are borne along. The continental press teems with admirable works on every department of natural history; and our subject has obtained, to say the least of it, its full share of consideration. Professor Hoffman's map, alluded to in my former address, will soon be illustrated by a work which promises fair to make the north of Germany once more the classic land of geology. The excellent Memoirs of MM. de Beaumont and Dufrénoy will soon be followed by the Geological Map of France,—a great national work, to appear, I hope, before the expiration of this year. I select these subjects, not merely on account of their general importance, but because they have an immediate relation to the structure of this country, and to the best labours of our own body.

The organization of the Geological Society of Paris belongs to the history of the preceding year: and when we consider the incomparable collections of that capital, and the illustrious naturalists who are there assembled, we confidently look to this association for results which shall greatly affect the future history of our science. With ordinary fortune it can hardly fail to become a great central point of union, where geologists from all the nations of Europe may from time to time meet together with no rivalry but in the love of truth.

Our studies, Gentlemen, have no part in those bad passions by which mankind are held asunder; the boundaries of tribes and nations are blotted out from our maps; the latest revolutions we treat of are anterior to the records of our race, and compared with the least of the monuments which we decipher, all the works of man's hand vanish out of sight. If we have advanced with a vigorous step for the last fifteen years, it has been during the peace of the civilized world. The foundations on which we build are so widely parted, that we require nothing less than a free range through all the kingdoms of the earth; and if any thing should occur to cloud our prospects or retard our progress, it must be accompanied by some moral plague which will desolate the face of Europe. Against the visitation of such a calamity, every man whom I now address will join with me in heartfelt aspirations.

Geology is a science of observation: and it is a humiliating fact, forced upon us at every step of our progress, that the material combinations we investigate and attempt to classify are too rude and ill defined to be regarded as the appreciable results of any simple law of nature. Some great and simple problems in physics have however so immediate a connexion with the structure of the earth, that we may almost claim their solutions for our own.

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The form put on by a fluid body in rotation is an abstract question, which might or might not have any real application to the bodies of our solar system. But direct geodesic observations, as well as the relative position of land and water, prove that the stratified matter on the crust of the earth is deposited in near conformity to the surface of a true spheroid of rotation. Here then we have, in spite of one of the arbitrary dogmas of the Huttonian theory, an indication of a primeval fluidity before the commencement of any one phænomenon coming within the direct speculations of geology. And again, the direct phænomena of geology are in the strictest harmony with this conclusion. For, after passing through a few stages of stratified matter, formed by the degradation of matter in a prior state of solidity, we are conducted to other unstratified masses with that crystalline structure which implies an anterior fluidity—in some cases unequivocally, and in all cases probably, derived from the solvent power of heat.

But if the earth ever existed in any state approaching to igneous fusion, it must have undergone a great diminution of temperature before it was fitted for the habitation of any organized being. And here again geological facts are at least in a general accordance with the hypothesis; for the forms of the living beings entombed among the ancient strata, not only seem to indicate a high temperature, but also a gradual refrigeration of the surface of the earth

Here however we meet with an unexpected difficulty. If during any period the earth have undergone a sensible refrigeration, it must also have undergone a contraction of its dimensions; and also, as a necessary consequence of a well known mechanical law, an acceleration round its axis of rotation. But direct astronomical observations prove that there has been no sensible diurnal acceleration during the last 2000 years; and therefore, by inverting the steps of the reasoning, we prove—that during that long period there has been no sensible diminution in the mean temperature of the earth. This difficulty does not, however, entirely upset the previous hypothesis: it only proves that the earth had reached an equilibrium of mean temperature before the commencement of good astronomical observations.

But if, Gentlemen, our speculations are thus limited and guided by the observations of astronomy, we have in part paid back to that exalted science the obligations we owe to it. The great bodies of our system leave behind them no marks to track their progress through the heavens; and the vast secular periods we can calculate, reaching to ages long anterior to the records of our being, might be mere fictions of the mind which have never had any archetype in nature. But in the phænomena of geology we are carried back, almost at our first step, into times unlimited by any narrow measures of our own; and we exhibit and arrange the monuments of former revolutions requiring for their accomplishment perhaps all the secular periods of astronomy. Nor is this all. We show by help of records, not to be misinterpreted, that during this vast

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lapse of time, in the very contemplation of which our minds become bewildered, the law of gravitation underwent no change, and the powers of atomic combination were still performing their office.

If the phænomena of geology be coeval with long returning astronomical periods (and it is at least impossible to prove the contrary), a question may arise, whether some of the first difficulties we meet with (such as those connected with the transport of diluvial gravel, and the gradual diminution of temperature,) may not be attributed rather to effects of planetary perturbation than to any change in the internal condition of the earth. This question has been admirably discussed in a recent paper by Mr. Herschel.

Of all the secular inequalities produced by perturbation, those of the moon alone can produce any visible effects upon the tidal level. The lunar inequalities considered are of two kinds—change of mean distance, and change of eccentricity. Both are confined within narrow determined limits; and Mr. Herschel shows, by actual calculation, that they could not have produced any of the great movements contemplated in geology.

The planetary perturbations of the orbit of the earth are next considered, and the influences they may have produced on the diffusion of light and heat. The secular variation of obliquity is too small to have ever caused any sensible effect on our climates: but he proves, by direct calculation, that the mean annual diffusion of solar light and heat varies inversely as the minor axis of the orbit; or, in other words, increases or diminishes with the increase or diminution of eccentricity. Now, as a matter of fact, the eccentricity of the earth's orbit has been for many ages slowly diminishing, and is now very small; but the limits of its secular variation have not yet been calculated. He assumes therefore, hypothetically, that the eccentricity of our orbit *may* once have been as great as that of some of the inferior and superior planets; and on that supposition he proves, that the slow diminution of eccentricity *may* have produced a gradual change of climate, of the very kind indicated by geological phænomena.

Several other great modifications in the diffusion of light and heat are involved in this hypothesis, one only of which I will mention, as it can be easily explained. It is well known that the place of the apogee and the equinoctial points are both in continual movement; and after the completion of a long cycle, these points will have travelled through the whole circumference of our orbit; whence it follows—that, during one part of the great astronomical cycle, our summers would coincide with the greatest, and during another with the least distance from the sun. And these conditions, in an orbit of considerable eccentricity, would produce, at one time a climate resembling perpetual spring; at another, the extreme vicissitudes of a burning summer and a rigorous winter.

Whether influences of this kind ever have caused any considerable effects on the climate of different portions of our globe, must, however, still remain in doubt, as the calculations are only founded on analogy. We rejoice, however, to associate our science with

with these lofty speculations, in which man seems to be no longer a worshiper at the portal of Nature's temple, but is allowed to pass within, and to be so far a partaker of her mysteries, as to see with his intellectual eye both the past and the future.

I believe that the law of gravitation, the laws of atomic affinity, and, in a word, all the primary modes of material action, are as immutable as the attributes of that Being from whose will they derive their only energy. But it is not merely through the simple and unchangeable modes of material action, or through the simple laws by which the parts of material things are bound together, that the works of nature are submitted to our senses. The things we see on the surface of the earth are in a continual state of movement and change, of destruction and renovation. They are not merely subject to those fundamental powers, commonly considered as the laws of nature; but the very powers themselves act under such endless modifications, sometimes combined together, and sometimes in conflict, that there follow from them results of indefinite complexity, the very simplest of which are removed far out of the reach of any rigid calculation.

As the primary laws of matter are immutable, every physical experiment tried under the same conditions must end in the same results, whether they be chemical, or mechanical, or a compound of both. But let any new and unknown condition be introduced, and the results are not only changed, but are often the very contrary of what we should have at first anticipated. Let it again be considered within what narrow limits we have the power of modifying the conditions of any physical experiment, and how little we still know of those mysterious imponderable agents which co-exist perhaps, with gravitation, and unquestionably play their part in every change and every combination—and we must see the utter hopelessness of bringing under the definite calculations of any mechanical law, those mighty combinations still going on in the great laboratory of nature.

Of the origin of volcanic forces we know nothing: but we do know that they are the irregular secondary results of great masses of matter obeying the primary laws of atomic action—that they differ in their intensity—are interrupted in their periods—and are aggravated or constrained by an endless number of causes, external and purely mechanical. Of all modes of material combination, those of which I now speak are perhaps the most complicated. To assume, then, that volcanic forces have not only been called into action at all times in the natural history of the earth, but also, that in each period they have acted with equal intensity, seems to me a merely gratuitous hypothesis, unfounded on any of the great analogies of nature, and I believe also unsupported by the direct evidence of fact. This theory confounds the immutable and primary laws of matter with the mutable results arising from their irregular combination. It assumes, that in the laboratory of nature, no elements have ever been brought together which we ourselves have not seen combined; that no forces have been developed by their combination, of which we have not witnessed the effects. And what is

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this but to limit the riches of the kingdoms of nature by the poverty of our own knowledge; and to surrender ourselves to a mischievous, but not uncommon philosophical scepticism, which makes us deny the reality of what we have not seen, and doubt the truth of what we do not perfectly comprehend?

Into the solution of the great problem of the heavenly bodies, there enter only a few simple and unchangeable mechanical elements, and the conclusions are of a simplicity corresponding to the simplicity of the premises. All the celestial movements return into themselves; and even the most complex of the deviations produced by mutual perturbation, are confined within narrow limits, and are completed in secular periods. The solution of this problem is incontestably the greatest triumph of exact science. But with what semblance of physical truth can we apply such mathematical results as these to the great phænomena of geology—where the combinations are mutable and indefinite—where we have no vestige of returning periods—and where the fixed elements of force are either unknown or imperfectly comprehended?

If all the complex groups of crystalline and stratified rocks; if, in a word, all the material things existing on the surface of the globe, be bound to each other by laws like those which govern the movements of the heavenly bodies—*then* every material combination we now see must re-appear with all its complicated relations after the lapse of some long period of time. But would not such a supposition be now regarded as the mere wantonness of hypothetical extravagance? And let it not be said, that it is only in the greater combinations on the surface of the earth that we are to look for returning cycles. Great and small have no meaning, except in reference to us and our conceptions. The earth is an atom in comparison with the visible creation; and all we now behold may be but as an atom in comparison of that which is unseen; and the meanest combinations of material things submitted to our senses propagate their influence through all space co-extensive with gravitation, and play their part in keeping up the stability of the universe.

To the supreme Intelligence, indeed, all the complex and mutable combinations we behold, may be but the necessary results of some simple law, regulating every material change, and involving within itself the very complications, which we, in our ignorance, regard as interruptions in the continuity of Nature's work. In contemplations of this kind our understanding is lost among the stern doctrines of philosophical necessity. But, as far as regards us and our faculties, there is no such thing on earth as undeviating moral or physical necessity. For as, in morals, necessity is made, in part, at least, subordinate to the freedom of human will; so, in physics, the continued action of immutable causes may and does co-exist with mutable phenomena.

The study of the great physical mutations on the surface of the earth is the business of geology. But who can define the limits of these mutations? They have been drawn by the hand of nature, and may be studied in the record of her works—but they never have been, and never will be fixed, by any guesses of our own, or by

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any trains of *a priori* reasoning, based upon hypothetical analogies. We must banish all *à priori* reasoning from the threshold of our argument; and the language of theory can never fall from our lips with any grace or fitness, unless it appear as the simple enunciation of those general facts, with which, by observation alone, we have at length become acquainted.

I should not have detained you one moment in enunciating propositions such as these, had I not believed that their true import had been partially misunderstood, and their spirit sometimes violated in a recent work on the "Principles of Geology." Before I proceed with this remark, let me, however, first discharge a debt of gratitude to the author, which, as yet, remains unpaid. Were I to tell him of the instruction I received from every chapter of his work, and of the delight with which I rose from the perusal of the whole, I might seem to flatter rather than to speak the language of sober criticism; but I should only give utterance to my honest sentiments. His work has already taken, and will long maintain a distinguished place in the philosophic literature of this country; higher praise than this I know not how to offer; and when, by publishing another volume (for which we all look with earnest anticipation), he shall have recorded his discoveries in a field of observation, almost his own; he will then have reaped the honour of being the first writer in our country to make known a general system of "geological dynamics,"—a new province gained by the advance of modern science.

But Mr. Lyell appears not only as the historian of the natural world, but as the champion of a great leading doctrine of the Huttonian hypothesis: and it is to the effects produced on the principles of his work by the latter character, that I now wish to call your attention, with all the freedom belonging to fair discussion and the love of truth. It would, indeed, be a strange anomaly in the history of physics, if the Huttonian hypothesis, framed by its distinguished author, without any knowledge of the most important facts of secondary geology, should require no new adjustments,—no limitation of its principles during the progress of discovery. I cannot but regret, that from the very title page of his work, Mr. Lyell seems to stand forward as the defender of a theory. An hypothesis is indeed (when we are all agreed in receiving it) an admirable means of marshalling scattered facts together, and exhibiting them in all the strength of combination. But by those who differ from us, an hypothesis will ever be regarded with just suspicion; for it too often becomes, even in spite of our best efforts, like a false horizon in astronomy, and vitiates all the great results of our observations, however varied, or many times repeated.

It cannot, I think, be doubted, that in the general statement of his results, Mr. Lyell has, unconsciously, been sometimes warped by his hypothesis, and that, in the language of an advocate, he sometimes forgets the character of an historian. In reading his graphic and eloquent descriptions of the mighty works of degradation yearly going on through the eastern shores of England, or of the enormous weight of solid matter hourly rolled down by the Ganges

Ganges or the Missisippi, I have fancied that the earth was sliding off from under my feet, and that it would soon pass away, like the sand of an hour-glass, beneath the waters of the ocean.

But are there no antagonist powers in nature to oppose these mighty ravages—no conservative principle to meet this vast destructive agency? The forces of degradation very often of themselves produce their own limitation. The mountain torrent may tear up the solid rock, and bear its fragments to the plain below: but there its power is at an end, and the rolled fragments are left behind to a new action of material elements. And what is true of a single rock is true of a mountain chain; and vast regions on the surface of the earth, now only the monuments of spoliation and waste, may hereafter rest secure under the defence of a thick vegetable covering, and become a new scene of life and animation.

It well deserves remark, that the destructive powers of nature act only upon lines, while some of the grand principles of conservation act upon the whole surface of the land. By the processes of vegetable life, an incalculable mass of solid matter is absorbed, year after year, from the elastic and non-elastic fluids circulating round the earth, and is then thrown down upon its surface. In this single operation, there is a vast counterpoise to all the agents of destruction. And the deltas of the Ganges and the Missisippi are not solely formed at the expense of the solid materials of our globe, but in part, and I believe also in a considerable part, by one of the great conservative operations by which the elements are made to return into themselves.

Let me not, however, be misunderstood. I am not denying the great processes of degradation so admirably described by Mr. Lyell; but I contend that to estimate their whole effects is a problem of such complexity, and so variable in its conditions, that its true nature is not fairly placed before the mind by the mere enumeration of a few extreme cases, or the description of a few striking instances. If I were to speculate upon the method of solving this problem, I should compare it to the summation of a converging series — the successive terms of degradation may be infinite, but the whole result may still perhaps be limited and finite.

It is impossible for me now to grapple with Mr. Lyell's whole argument; but it appears to me, that volcanic action is not the only true conservative principle, and is rather to be regarded as the great productive principle, by which the solid matter on the surface of the globe has been lifted above the waters: and that the grand principles of conservation are to be looked for among the operations of the elements themselves, assisted by the combined action of animal and vegetable life.

According to the principles of Mr. Lyell, the physical operations now going on, are not only the type, but the measure of intensity of the physical powers acting on the earth at all anterior periods: and all we now see around us is only the last link in the great chain of phænomena, arising out of a uniform causation, of which we can trace no beginning, and of which we see no prospect of the end. And in all this, there is much that is beautiful and true. For we all allow,

allow, that the primary laws of nature are immutable—that all we now see is subordinate to those immutable laws—and that we can only judge of effects which are past, by the effects we behold in progress. Whether there be, or be not, any physical traces of a state of things anterior to the commencement of our geological series of deposits, is a question of no real importance. But to assume that the secondary combinations arising out of the primary laws of matter, have been the same in all periods of the earth, is, I repeat, an unwarrantable hypothesis with no *a priori* probability, and only to be maintained by an appeal to geological phænomena.

If the principles I am combating be true, the earth's surface ought to present an indefinite succession of similar phænomena. But as far as I have consulted the book of nature, I would invert the negative in this proposition, and affirm, that the earth's surface presents a definite succession of dissimilar phænomena. If this be true, and we are all agreed that it is; and if it be also true, that we know nothing of second causes, but by the effects they have produced; then, "the undeviating uniformity of secondary causes,"—the "uniform order of physical events,"—"the invariable constancy in the order of nature," and other phrases of like kind, are to me, as far as regards the phænomena of geology, words almost without meaning. They may serve to enunciate the propositions of an hypothesis; but they do not describe the true order of nature*.

Each formation of geology may have required a very long period for its complete development; and of such an element as past time, we grudge no man the appropriation. But after all, the successive formations, about which we speculate, however complex in their subdivisions, are small in number: and after deciphering a series of monuments, we reach the dark ages of our history, when, having no longer any characters to guide us, we may indulge at will in the creations of our fancy. We may imagine indefinite cycles, and an indefinite succession of phænomena; and in the physical world, as well as in the moral, we may have our long periods of fabulous history. But these things belong not to inductive geology; and all I now contend for is—that in the well established facts brought to light by our investigations, there is no such thing as an indefinite succession of phænomena.

I will not, even in imagination, travel with you over the successive formations of the earth, or point out their mineralogical distinctions; but I may remind you, that in the very first step of our progress we are surrounded by animal and vegetable forms, of which there are now no living types. And I ask, have we not in these things some indication of change and of an adjusting power altogether different from what we commonly understand by the laws of nature? Shall we say with the naturalists of a former century, that they are but the sports of nature? Or shall we adopt the doctrines of spontaneous generation and transmutation of species, with all their train of monstrous consequences? These subjects,

* Principles of Geology, p. 75, 76, 86, &c. &c.

jects, indeed, are not yet touched upon by Mr. Lyell; and I throw out these remarks only to show by what difficulties the Huttonian hypothesis is encountered—of a kind, too, never present to the mind of its inventor.

There is however one chapter in the "Principles of Geology" where the author combats the doctrine of the progressive development of organic life, and briefly considers the distribution of fossil bodies in the successive strata of the earth. I admit the general truth of his facts and the strength of his argument, and I allow that he has succeeded in exposing some of the errors and misstatements of his opponents. A doctrine may however be abused, and yet contain many of the elements of truth. With reference to the functions of the individual being, one organic structure is as perfect as another. But I think that in the repeated and almost entire changes of organic types in the successive formations of the earth—in the absence of mammalia in the older, and their very rare appearance (and then in forms entirely unknown to us) in the newer secondary groups—in the diffusion of warm-blooded quadrupeds (frequently of unknown genera) through the older tertiary systems—in their great abundance (and frequently of known genera) in the upper portions of the same series—and, lastly, in the recent appearance of man on the surface of the earth (now universally admitted)—in one word, from all these facts combined, we have a series of proofs the most emphatic and convincing,—that the existing order of nature is not the last of an uninterrupted succession of mere physical events derived from laws now in daily operation: but on the contrary, that the approach to the present system of things has been gradual, and that there has been a progressive development of organic structure subservient to the purposes of life.

Considered as a mere question of physics, (and keeping all moral considerations entirely out of sight,) the appearance of man is a geological phænomenon of vast importance, indirectly modifying the whole surface of the earth, breaking in upon any supposition of zoological continuity, and utterly unaccounted for by what we have any right to call the laws of nature.

If by the laws of nature we mean only such manifestations of power as seem good to the supreme Intelligence, then there can be no matter for dispute. But in physical questions such terms as the "laws of nature" have a proper reference only to second causes: and I ask, by what operation of second causes can we account for the recent appearance of man? Were there no other zoological fact in secondary geology, I should consider this, by itself, as absolutely subversive of the first principles of the Huttonian hypothesis.

If the principles vindicated in Mr. Lyell's work be true, then there can be no great violations of continuity either in the structure or position of our successive formations. But we know that there are enormous violations of geological continuity: and though relatively speaking many of them may be local, of this at least we are certain, that they have been produced by forces adequate to the effects and coextensive with the phænomena.

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The very first step we take, we see a violation of continuity. Between the alluvial silt, deposited by the waters now flowing off from the inequalities of the earth, and the masses of diluvial gravel scattered over so many parts of its surface, we can seldom establish any appearance of continuity, or give any intelligible proof of their common origin. I am not going now to plunge into this long debated question; but I may remind you of the enormous waterworn blocks (derived from the primary chains to the north of the Baltic Sea), which lie scattered over the great European plain, extending from the eastern states of Holland to the Steppes of central Russia. Where are the inclined planes down which these boulders could have descended? Where are the grooves and channels cut out by the rivers which once propelled them? Where is the alluvial silt accumulated by the erosion of these ideal waters? No answer can be given to these questions: and to talk of river action, aided as it may have been by every ordinary power of nature, appears to me, in a case like this, little better than a mockery of my senses.

Hundreds of instances leading to a like conclusion (on a less scale indeed, and therefore perhaps the less impressive,) may be found among the phænomena of our island*.

If indeed we were to admit a period of intense volcanic violence, and a sudden elevation of the Scandinavian chain, we might then have a cause commensurate to the effects observed, and in the rush of the retiring waters we might explain the transport of those great boulders which lie scattered over the northern plains of Europe. But in the speculations I am combating, all great epochs of elevation are systematically, and I think unfortunately, excluded. Volcanic action is essentially paroxysmal; yet Mr. Lyell will admit no greater paroxysms than we ourselves have witnessed—no periods of feverish spasmodic energy, during which the very framework of nature has been convulsed and torn asunder. The utmost movements that he allows are a slight quivering of her muscular integuments.

But if we have proofs of the violation of continuity among the most recent deposits on the earth, still more impressive are the proofs as we descend in the geological series. Every observer is aware that we often pass, without any intermediate gradations, from systems of strata which are horizontal, to other systems which are highly inclined. This is a fact independent of hypothesis; but it is now almost universally admitted, that the highly inclined strata have undergone a movement of elevation. Using then the language of this hypothesis (to say the least of it a convenient mode of describing the phænomena)—we affirm that the inclined strata have been elevated at a time anterior to the existence of the horizontal strata which abut against them, or rest upon their edges. And if

* The diluvial phænomena of this country are so well known, that it is perhaps unnecessary to appeal to them: but I wish to refer the reader to the papers of Sir James Hall (published in the Edinburgh Transactions), for some very remarkable proofs of the action of diluvial currents in the neighbourhood of Edinburgh.

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the ages of the inclined and horizontal strata be defined, we also necessarily define the period of the elevation.

This kind of reasoning has for some years been familiar to the geologists of Europe. Mr. Webster endeavoured to prove that the Isle of Wight had been upset after the period of the London clay, and before that of the lacustrine rock marl. Every one now admits, (and indeed it is made the foundation of one of the classifications of Mr. Conybeare,) that our carboniferous chains were elevated before the period of the new red sandstone.

But the researches of M. Elie de Beaumont, to which I now wish to direct your attention, have given a vast extension to the observations of all those who had gone before him. And before I proceed I cannot but lament that persons, who have not perhaps comprehended the meaning of this admirable observer, should have nibbled at the originality of his discoveries; as if the very essence of philosophical discovery did not often consist in bringing to a point all the scattered lights of former observations, and giving generalization to insulated phænomena.

In the first place then, by an incredible number of well conducted observations of his own, combined with the best attested facts recorded by other observers, he has proved, on the principles already pointed out—that whole mountain chains have been elevated at one geological period—that great physical regions have partaken of the same movement at the same time—and that these paroxysms of elevatory force have come into action at many successive periods. Distinguished as are his merits, he so far claims not an undivided honour. But in the next great step of generalization he reaches a position where he stands entirely by himself.

Step by step we had been advancing towards the conclusion—that different mountain chains had been elevated at several distinct geological periods: and by a long series of independent observations, Humboldt, Von Buch, and other great physical geographers, had proved—that the mountain chains of Europe might be separated into three or four distinct systems; distinguished from each other, if I may so express myself, by a particular physiognomy, and, above all, by the different angles made by the bearings of their component formations with any assumed meridian. All the subordinate parts of any one system were shown to be parallel; while the different systems were inclined at various angles to each other.

By an unlooked-for and most felicitous generalization, M. Elie de Beaumont has now proved that these two great classes of facts are commensurate to each other; and that each of these great systems of mountain chains, marked on the map of Europe by given parallel lines of direction, has also a given period of elevation, limited and defined by direct geological observation. The steps by which he reaches this noble generalization are so clear and convincing, as to be little short of physical demonstration. It forms an epoch in the history of our science; and I am using no terms of exaggeration when I say, that in reading the admirable researches of M. de Beaumont I appeared to myself, page after page, to be acquiring a new

new geological sense, and a new faculty of induction: and I cannot express my feelings of regret, that during my recent visit to the Eastern Alps I did not possess this grand key to the mysteries of Nature.

I am aware how impossible it is in a few words to give any clear notion of a volume of condensed original researches. Dropping all minor details, I may, however, claim your indulgence while I point out the author's manner of induction in four great systems of European chains: not indeed in the wish of quenching the curiosity of those who have not studied this question, but rather in the hope of urging them to seek the fountain of original information.

1. The first system includes the higher elevations, in eastern France, of the Côte d'Or and Mont Pilas, and a portion of the Jura chain. It may be traced towards the valley of the Rhine, where it is suddenly cut off; but it reappears in the chain of the Erzgebirge, between Bohemia and Saxony. It never rises into mountains of the first order, but is marked throughout (as may be seen on a good physical map) by many longitudinal ridges and furrows, ranging nearly parallel to each other in a direction about north-east and south-west. So far the statement is only an enumeration of certain connected facts in physical geography. But it is followed by a coordinate series of geological phænomena.

A number of formations, including in the ascending order the whole oolitic series, enter here and there into the composition of the geographical system above described; and, without exception, wherever they appear all are in turn elevated, broken, or contorted; yet in their lines of range they preserve a parallelism to the general direction of the ridges. On the contrary, wherever rocks of an age not older than that of the green-sand or chalk, appear in the vicinity of any portion of this system, they are either found at a dead level and expanded from the neighbouring mountains into horizontal planes, like the sea at the base of a lofty cliff; or if, since their first deposit, they have undergone any great movement, it is shown to have no relation to the bearing of the older ridges, and to have been produced at a later period.

From all these combined facts follow three important consequences. 1st, That the whole system of parallel ridges, from one end to the other, was elevated at the same period of time, after the development of the oolitic series, and before the deposition of the green-sand and chalk. 2ndly, That the action of elevation was violent and of short continuance, for the inclined strata are shattered and contorted; and between them and the horizontal strata there is no intermediate gradation of deposits. 3rdly, That the period of elevation was followed by an immediate change in many of the forms of organic life.

2. The next great system includes the whole chain of the Pyrenees—the Northern Apennines—the calcareous chains to the north-east of the Adriatic—nearly the whole Carpathian chain—and a great series of inequalities, continued from that chain through the Hartz mountains to the plains of Northern Germany. Through the

the whole of these vast regions the principal inequalities range nearly parallel to each other, and have a mean bearing about west-north-west and east-south-east. So far again the statement is purely geographical, and its truth is seen at once in glancing over any good physical map of Europe; and will be still more clearly comprehended, by comparing some of the principal ranges of colour on Von Buch's great geological map with the bearing of the Pyrenees. But it is followed by a series of co-extensive geological phænomena.

Through all parts of this great system, formations of the age of the green-sand and chalk have had an enormous development, and without exception, their strata are ruptured and contorted, and often lifted up to the very pinnacles of the mountains. But on the contrary, wherever any tertiary formations approach the confines of this system, they are stated to be either in a position almost as horizontal as the surface of the waters in which they were deposited; or if they have been moved at all, it is by forces uninfluenced by the parallels of the older chains. And the same three conclusions, with a mere difference of dates, follow here as in the former case. All the great parallel ridges and chains of this second system must have been suddenly and violently elevated, and at a period of time between the deposition of the chalk and the commencement of the tertiary groups; and the corresponding change in organic types is, in this instance, still more striking than in the former.

3. The third system embraces a great number of parallel inequalities, bearing about north-north-east and west-south-west, and includes the whole Western Alps, from the neighbourhood of Marseilles to the volcanic ridges near the foot of the Lake of Constance. And by an hypothetical, but I think probable extension, it also takes in the whole of the great Scandinavian chain.

I cannot enter on the elaborate and satisfactory details by which it is proved—that all these great parallel inequalities in the region of the Western Alps had their origin after the tertiary *molasse,* a deposit partaking of all the elevations and contortions of the older strata—that the elevatory movements were sudden and violent, and commenced at a time when tribes of mammalia (the remains of which in England are hardly ever found except in the superficial gravel) flourished in many parts of Europe—that these movements were immediately succeeded by great horizontal deposits of old diluvial gravel at the base of the Western Alps; and probably also by that vast offshot of Scandinavian rocks which lie scattered over the northern plains of Germany.

4. The fourth system embraces many great parallel ridges having a range about east-north-east and west-south-west, and includes several considerable chains in Provence, and nearly the whole chain of the Eastern Alps—from the great flexure in the region of Mont Blanc to the Alps of the states of Austria.

It would be impossible to follow the author through details occupying a large portion of his volume. I may however state, that he proves the formations of the Eastern and Western Alps not to pass into each other by any flexure of the strata coinciding with the bend of the whole

whole chain; but to meet at an angle marked by a great double system of breaks and fissures, one passing in the direction of the eastern, and the other of the western portions of the chain. He further proves, that the system of fissures in the line of the Eastern Alps is more recent than the other system—that in the prolongation of this line towards the west, the old diluvial gravel has undergone movements of elevation—and that these movements have been propagated to the lacustrine and volcanic regions of Auvergne.

On a review of the whole evidence, I think he has demonstrated, that there are two distinct deposits of diluvial gravel near a portion of the Western Alps—that the colossal mass of Mont Blanc, and at least a considerable portion of the Eastern Alps, were elevated after the deposit of the older diluvium—and that the newer diluvium (including all those enormous crystalline erratic blocks so admirably described by Saussure) rolled off from the regions of the higher Alps during this last period of their elevation.

There are six other supposed periods of elevation briefly considered in the researches of M. Elie de Beaumont, each marked by distinct geographical features: but I will not now detain you with their enumeration. If the generalizations to which I have pointed be true, and, as far as I comprehend them, they seem to be based on an immoveable mass of evidence, we must then conclude that there have been in the history of the earth long periods of comparative repose, during which the sedimentary deposits went on in regular continuity, and comparatively short periods of violence and revolution, during which that continuity was broken. And if we admit that the higher regions of the globe have been raised from the sea by any modification of volcanic force, we must then also admit that there have been several successive periods of extraordinary volcanic energy.

How we are to escape from this conclusion I am unable to comprehend, unless we shut out the evidence of our senses. Of volcanic powers we know nothing, except during the irregular periods of their activity—and returning periods of intense activity, after long ages of comparative repose, may be among the enduring principles in the mechanism of nature. I do not throw this out as even a probable hypothesis; but it is, at least, as probable as any other hypothesis unfounded on the evidence of geological phænomena.

That the system of M. Elie de Beaumont is directly opposed to a fundamental principle, vindicated by Mr. Lyell, cannot admit of doubt. And I have decided to the best of my judgement, in favour of the former author, because his conclusions are not based upon any *a priori* reasoning, but on the evidence of facts; and also, because, in part, they are in accordance with my own observations*.

* For example; the vertical position of the green-sand and chalk on the eastern flank of the Hartz mountains, and the horizontal position of the same formations on the flanks of the Erzgebirge, were remarked by Mr. Murchison and myself in the summer of 1829. During the same tour we had repeated proofs of the recent elevation of the chain of the Eastern Alps; of the high elevation of the green-sand series in the calcareous chain to the north-east of Trieste; and of the horizontality of the tertiary deposits of Styria. All these facts (of which we did not at the time comprehend the whole importance) harmonize with the system of M. de Beaumont.

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Let me not, however, be misunderstood. I have been offering no general criticism of Mr. Lyell's work: I have merely been arguing against the extension of one hypothetical principle (an important one indeed in the interpretation of geological phænomena) on which we differ in opinion. Nineteen twentieths of his work remain untouched by these remarks. His excellent and original historic narrative—his dignified philosophic views and clear descriptions—his admirable account of the effects brought about by the great causes, whether aqueous or igneous, now acting on the crust of the globe, contribute to make his volume, in the highest degree, both popular and instructive; and I cannot but express a wish, that, in the future editions of his work, the system of "geological dynamics" may be stripped of even the semblance of hypothetical assumption; and that having first ascertained by a mere appeal to facts, what the powers of nature now are (and I know no one more competent to the task), he will then proceed to apply them to the solution of the dark problems of geology. This arrangement would not only be the most fair and logical, but would take away that controversial character, by which, in my opinion, some pages of his present volume are disfigured; and would, in the end, give him incomparably the best chance, either of limiting or extending his own principles, as might seem good during the advances of our science. What he has written with so much power, must inevitably produce a great impression on the English school of geology. It is on this account, and not with any spirit of unfriendly criticism, that I have discussed, at greater length than I first intended, the points on which we differ; and I am only anxious, that a work abounding in so many admirable details, should hereafter appear, as far as any human production can do, without a blemish in the enunciation of a single principle.

Greatly as I admire the generalizations of M. de Beaumont, they have, I think, been already pushed too far. We may follow them as our guides, but they must never take the place of direct observations. It is only through limited regions of the earth that we shall perhaps be ever able to make out the true parallels of contemporaneous elevation. Distant continents may have independent parallel systems of elevation. In several mountain chains (for example, in the Eastern Alps) we have direct proof, that the forces of elevation have acted on the same line at successive epochs; and in our island, there have been movements of elevation at different epochs, yet on lines which are parallel. Lastly, lines of elevation (like the existing lines of modern volcanic vent) may, in their prolongation, have deflected far from their first direction. But I must forbear, for the discussion of these questions would lead me into endless details*.

* That part of the generalizations of M. Elie de Beaumont, in which he seems to assume, that each great period of elevation was followed by a great change in organic forms, is, perhaps, the least secure. In England, there is a great break between the greywacké and carboniferous systems; yet the fossils, in the calcareous groups, alternating with the greywacké, very nearly approach to those of the carboniferous limestone. There is also a great break between the carboniferous and magnesian limestone series of this country; but their suites of fossils very nearly resemble each other, and several species are common to both. Again, on the outskirts of the calcareous zone of the Alps, there are large groups of strata, with fossils

At our former Anniversary I ventured to affirm, that our diluvial gravel was probably not the result of one, but of many successive periods. But what I then stated as a probable opinion, may, after the Essays of M. de Beaumont, be now advanced with all the authority of established truth: and among the many obligations we owe to this accomplished observer, I may mention the new and instructive views he has given us of the origin of the great masses of old detritus lying scattered over the lower regions of the earth. We now connect the gravel of the plains with the elevation of the nearest system of mountains; we believe that the Scandinavian boulders in the North of Germany are of an older date than the diluvium of the Danube; and we can prove, that the great erratic blocks, derived from the granite of Mont Blanc, are of a more recent origin than the old gravel in the tributary valleys of the Rhone. That these statements militate against opinions, but a few years since held almost universally among us, cannot be denied. But theories of diluvial gravel, like all other ardent generalizations of an advancing science, must ever be regarded but as shifting hypotheses to be modified by every new fact, till at length they become accordant with all the phænomena of nature.

In retreating where we have advanced too far, there is neither compromise of dignity nor loss of strength; for in doing this, we partake but of the common fortune of every one who enters on a field of investigation like our own. All the noble generalizations of Cuvier, and all the beautiful discoveries of Buckland, as far as they are the results of fair induction, will ever remain unshaken by the progress of discovery. It is only to theoretical opinions that my remarks have any application.

Different formations of solid rock, however elevated and contorted, can never become entirely mixed together; and the very progress of degradation commonly lays bare all the elements of their structure. But diluvial gravel may be shot off from the flanks of a mountain chain, during a period of elevation, and become so confounded with the detritus of another period, that no power on earth can separate them: and every subsequent movement, whether produced by land floods or any other similar cause, must continually tend still further to mingle and confound them. The study of diluvial gravel is, then, not only one of great interest, but of peculiar difficulty and nice discrimination: and in the very same deposit, we may find the remains of animals which have lived during different epochs in the history of the earth.

Bearing upon this difficult question, there is, I think, one great negative conclusion now incontestably established — that the vast masses of diluvial gravel, scattered almost over the surface of the earth, do not belong to one violent and transitory period. It was indeed a most unwarranted conclusion, when we assumed the contemporaneity

fossils conforming both to the secondary and tertiary type. I must, however, add, in justice to the author, that his observations on the changes of organic forms, are casually thrown out, here and there, and do not seem to form any essential portion of his theory.

poraneity of all the superficial gravel on the earth. We saw the clearest traces of diluvial action, and we had, in our sacred histories, the record of a general deluge. On this double testimony it was, that we gave a unity to a vast succession of phænomena, not one of which we perfectly comprehended, and under the name diluvium, classed them all together.

To seek the light of physical truth by reasoning of this kind, is, in the language of Bacon, to seek the living among the dead, and will ever end in erroneous induction. Our errors were, however, natural, and of the same kind which led many excellent observers of a former century to refer all the secondary formations of geology to the Noachian deluge. Having been myself a believer, and, to the best of my power, a propagator of what I now regard as a philosophic heresy, and having more than once been quoted for opinions I do not now maintain, I think it right, as one of my last acts before I quit this Chair, thus publicly to read my recantation.

We ought, indeed, to have paused before we first adopted the diluvian theory, and referred all our old superficial gravel to the action of the Mosaic flood. For of man, and the works of his hands, we have not yet found a single trace among the remnants of a former world entombed in these ancient deposits. In classing together distant unknown formations under one name; in giving them a simultaneous origin, and in determining their date, not by the organic remains we had discovered, but by those we expected hypothetically hereafter to discover, in them; we have given one more example of the passion with which the mind fastens upon general conclusions, and of the readiness with which it leaves the consideration of unconnected truths.

Are then the facts of our science opposed to the sacred records? And do we deny the reality of a historic deluge? I utterly reject such an inference. Moral and physical truth may partake of a common essence, but as far as we are concerned, their foundations are independent, and have not one common element. And in the narrations of a great fatal catastrophe, handed down to us, not in our sacred books only, but in the traditions of all nations, there is not a word to justify us in looking to any mere physical monuments as the intelligible records of that event: such monuments, at least, have not yet been found, and it is not perhaps intended that they ever should be found. If, however, we should hereafter discover the skeletons of ancient tribes, and the works of ancient art buried in the superficial detritus of any large region of the earth; then, and not till then, we may speculate about their stature and their manners and their numbers, as we now speculate among the disinterred ruins of an ancient city.

We might, I think, rest content with such a general answer as this. But we may advance one step further—History is a continued record of passions and events unconnected with the enduring laws of mere material agents—The progress of physical induction, on the contrary, leads us on to discoveries, of which the mere light of history would not indicate a single trace. But the facts recorded in history may sometimes, without confounding the nature of

of moral and physical truth, be brought into a general accordance with the known phænomena of nature: and such general accordance I affirm there is between our historical traditions and the phænomena of geology. Both tell us in a language easily understood, though written in far different characters, that man is a recent sojourner on the surface of the earth. Again, though we have not yet found the certain traces of any great diluvian catastrophe which we can affirm to be within the human period; we have, at least, shown, that paroxysms of internal energy, accompanied by the elevation of mountain chains, and followed by mighty waves desolating whole regions of the earth, were a part of the mechanism of nature. And what has happened, again and again, from the most ancient, up to the most modern periods in the natural history of the earth, may have happened once during the few thousand years that man has been living on its surface. We have, therefore, taken away all anterior incredibility from the fact of a recent deluge; and we have prepared the mind, doubting about the truth of things of which it knows not either the origin or the end, for the adoption of this fact on the weight of historic testimony.

If, Gentlemen, I believed that the imagination, the feelings, the highest capacities of our nature, and the active intellectual powers bearing upon the business of life, were blunted or impaired by the study of our science, I should then regard it as little better than a moral sepulchre, in which, like the strong man, we were burying ourselves and those around us, in ruins of our own creating. But I believe too firmly in the immutable attributes of that Being, in whom all truth, of whatever kind, finds its proper resting place, to think that the principles of physical and moral truth can ever be in lasting collision. And as all the branches of physical science are but different modifications of a few simple laws, and are bound together by the intervention of common objects and common principles; so also, there are links (less visible, indeed, but not less real) by which they are also bound to the most elevated moral speculations.

At every step we take in physics, we show a capacity and an appetency for abstract general truth; and in describing material things, we speak of them, not as accidents, but as phænomena under the government of laws. The very language we use (and it is hardly possible for us to explain our meaning by any other), is the language in which we describe the operations of intelligence and power. And hence we admit, by the very constitution of our intellectual nature, and even in spite of ourselves, an *anima mundi* pervading all space, existing in all times, and under all conditions of being.

But we do not stop here; for the moment we pass on to that portion of matter, which is subservient to the functions of life, we there find all the phænomena of organization: and in all those beings the functions of which we comprehend, we see traces of structure in many parts as mechanical as the works of our own hands, and, so far, differing from them only in complexity and perfection; and we see all this subservient to an end, and that end accomplished. Hence, we are compelled to regard the *anima mundi* no longer as a uniform and

 quiescent

quiescent intelligence, but as an active and anticipating intelligence: and it is from this first principle of final causes, that we start with that grand and cumulative argument, derived from all the complex functions of organic nature.

Geology lends a great and unexpected aid to the doctrine of final causes; for it has not merely added to the cumulative argument, by the supply of new and striking instances, of mechanical structure adjusted to a purpose and that purpose accomplished; but it has also proved that the same pervading active principle, manifesting its power in our times, has also manifested its power in times long anterior to the records of our existence.

But after all, some men seeing nothing but uniformity and continuity in the works of nature, have still contended (with what I think a mistaken zeal for the honour of sacred truth), that the argument from final causes proves nothing more than a quiescent intelligence. I feel not the force of this objection. In geology, however, we can meet it by another direct argument; for we not only find in our formations organs mechanically constructed—but at different epochs in the history of the earth we have great changes of external conditions, and corresponding changes of organic structure; and all this without the shadow of a proof that one system of things graduates into, or is the necessary and efficient cause of, the other. Yet in all these instances of change, the organs, as far as we can comprehend their use, are exactly those which were best suited to the functions of the being. Hence we not only show intelligence contriving means adapted to an end, but at successive times and periods contriving a change of mechanism adapted to a change in external conditions. If this be not the operation of a prospective and active intelligence, where are we to look for it?

Our science is then connected with the loftiest of moral speculations; and I know no topic more fitting to the last sentiments I wish to utter from this Chair.

There is one way, and one way only, in which the higher intellectual powers may be cramped by the pursuit of natural truth, and that is by a too exclusive devotion to it. In the pursuit of any subject, however lofty, a man may become narrow-minded, and in a condition little better than that of moral servitude: but on this score we have not much to fear. Every department of science offers its spoils for our decoration; we are carried into regions where we contemplate the most glorious workmanship of Nature, and where the dullest imagination becomes excited; we are forced to travel through distant lands, and become familiar with the complexions, and the feelings, and the characters of mankind under every form of social life; and in doing this, if we be not most indocile learners, we must bear away lessons of kindness, and forbearance, and freedom of thought, along with the appropriate knowledge of our own vocation; and all this we can carry with us into the business of life. These, Gentlemen, are the high qualities which ought to form the ornament of this Society; and I am certain that I have seen their constant exercise in the intercourse and the discussions of this room, where mutual good-will,

will, frankness, and the love of truth, are the only dominant sentiments.

My own connexion with this Society during the two years I have had the honour to preside over its councils, has been to me a source of continued and heartfelt pleasure: and it would be with pain indescribable that I should now quit this Chair and bid you farewell, did I not think that I should very often meet the same friends, and partake in the same discussions.

Every man, whatever be his station, has a small circle of duties which are paramount to all others: but after these are performed, such powers as are given me shall ever be willingly devoted to your service. I do not mean this for empty boasting; that language would ill become me at any time, and least of all when I am leaving this Chair and descending into your ranks. Mine has been indeed but an interrupted service; but I resign it to one of whose powers you have had long experience, who can give them to you undivided, and whose hands are in no respect less ready than my own.

XLVIII. *Intelligence and Miscellaneous Articles.*

ON THE HARDNESS OF COPPER SLAG AS A MATERIAL FOR ROADS. BY B. BEVAN, ESQ.

To Richard Taylor, Esq. F.L.S. F.G.S. &c.

Dear Sir,

I HAVE availed myself of the first opportunity since my return from London, to try the hardness of the copper slag you put into my hands for that purpose. I find it the hardest material for roads I have yet met with, the number expressing its strength, conformable to the List in page 164 of your last Number, is 234, which is quite *double* the *highest* number in the said list. The specific gravity I find 4·32, which is nearly double that of the ordinary materials used for roads. Should the substance be all of equal hardness with the specimen I have tried, and not subject to decomposition upon exposure to the atmosphere, and the price prove moderate, it may be considered one of the most valuable articles for roads of great traffic and heavy loads.

By comparing its strength with *flint*, it will be found to possess *seven* times the resistance of that article.

I am, Dear Sir, yours very truly,

Leighton, March 22, 1831. B. BEVAN.

[The specimen of copper slag was received from Mr. H. Fisher of Newgate-street, whose laudable endeavours to procure it to be used for the carriage-way of Blackfriars Bridge have not met with the attention they deserve from the Common Council of London, or the Committee of General Purposes. It is much to be regretted that the Corporation is about to re-pave the Bridge, and thus to renew a cause of constant distress and injury to the horses which are drawing heavy weights over it, the attempts to keep up a Macadamized road having failed. The failure, however, is without doubt to be attributed to the use of an improper material,—the rolled flint of the London gravel,—which is reduced to powder by the first pressure to which it is subjected. How greatly inferior a material flint is for this purpose, plainly appears from the results obtained by Mr. Bevan.—R. T.]

LECTURES

LECTURES ON GEOLOGY.

Mr. John Phillips, F.G.S., Author of Illustrations of the Geology of Yorkshire, and of several papers on Geology in the Phil. Mag. and Annals, will deliver a Course of Lectures on Geology, at the University of London, during the months of April and May.

NEW SCIENTIFIC BOOKS.

Just published.

The Utility of the Knowledge of Nature considered; with reference to the introduction of Instruction in the Physical Sciences, into the General Education of Youth: comprising, with many additions, the details of a Public Lecture on that subject, delivered at Hazelwood School, near Birmingham, October 26th, 1830. By E. W. Brayley, Jun. A.L.S., Lecturer on Natural Philosophy and Natural History; Teacher of the Physical Sciences in the Schools of Hazelwood and Bruce Castle. 8vo.

LUNAR OCCULTATIONS.

Occultations of Planets and fixed Stars by the Moon, in April 1831. *Computed for Greenwich, by* THOMAS HENDERSON, *Esq.*; *and circulated by the Astronomical Society.*

1831.	Stars' Names.	Magnitude.	Ast. Soc. Cat. No.	Immersions.				Emersions.			
				Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.	Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.
				h m	h m	°	°	h m	h m	°	°
Apr. 15	Aldebaran	1	528	6 23	4 50	121	148	7 27	5 54	257	293
20	18 Leonis	6	1177	15 54	14 1	56	95	16 46	14 52	270	307
21	49 Leonis	6	1259	14 36	12 38	83	121	15 36	13 38	237	276

METEOROLOGICAL OBSERVATIONS FOR FEBRUARY 1831.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·431. Feb. 23. Wind W.—Min. 29·134. Feb. 1. Wind S.W.
Range of the mercury 1·297.
Mean barometrical pressure for the month .... 29·913
Spaces described by the rising and falling of the mercury........... 6·140
Greatest variation in 24 hours 0·644.—Number of changes 18.
Therm. Max. 60°. Feb. 9. Wind S.W.—Min. 31°. Feb. 5. Wind N.W.
Range 29°.—Mean temp. of exter. air 44°·70. For 29 days with ☉ in ♒ 42·24
Max. var. in 24 hours 18°·00.—Mean temp. of spring-water at 8 A.M. 48·65

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the evening of the 24th ... 96°
Greatest dryness of the atmosphere, in the afternoon of the 28th... 56
Range of the index 40
Mean at 2 P.M. 72°·6.—Mean at 8 A.M. 79°·7.—Mean at 8 P.M. 80·3
—— of three observations each day at 8, 2, and 8 o'clock .... 77·5
Evaporation for the month 1·15 inch.
Rain in the pluviameter near the ground 2·40 inches.
Prevailing winds, N.W. and S.W.

Summary

Summary of the Weather.

A clear sky, $3\frac{1}{2}$; fine, with various modifications of clouds, 11; an overcast sky without rain, $7\frac{1}{2}$; foggy, $\frac{1}{2}$; rain, hail and snow, $5\frac{1}{2}$.—Total 28 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
12	6	26	1	14	12	20

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
$1\frac{1}{2}$	1	0	$3\frac{1}{2}$	3	7	4	8	28

General Observations.—This month was generally showery, with occasional gales of wind, and mild for the season, except the first five days.

On the 1st instant, there were frequent falls of granulous snow mixed with hail in the day, and three inches in depth fell in the night. The following was also a snowy day, and the flakes were very large, loose, and moist, amounting to three inches in depth. Beyond York the snow about the same time is said to have drifted in the roads above twenty feet in depth. The maximum temperature of the external air for the twenty-four hours occurred in the night of the 3rd, and nearly all the snow disappeared here by the following morning. On the 9th, after a few showery and windy days, the thermometer in the shade rose to the unusual height of sixty degrees, when the heat seemed to descend to the earth from passing beds of beautiful cirrocumulus clouds; and in the course of the afternoon rudiments of thunder clouds passed over. In the afternoon of the 26th a fine rainbow appeared several minutes in a passing *nimbus*, with two small concentric ones of the same colours, but fainter, and a complementary bow above them. In the evening a bright yellow corona round the moon was circumscribed by small well defined rings of green and red.

The atmospheric and meteoric phænomena that have come within our observations this month, are two solar and three lunar halos, one rainbow and seven gales of wind, or days on which they have prevailed, namely, one from the North-east, two from the South-west, two from the West, and two from the North-west.

REMARKS.

London.—February 1. Heavy fall of snow in the morning: clear and fine at night. 2. Fine in the morning: sleet. 3. Frosty: fog: heavy rain at night. 4. Rain. 5. Cloudy and cold. 6. Fine in the morning: sleet. 7. Fine. 8. Rain. 9—12. Fine. 13. Rain. 14. Overcast. 15. Foggy in the morning: very fine. 16. Fine. 17. Showery: fine. 18. Fine. 19. Cloudy: rain at night. 20, 21. Fine, but cold. 22. Drizzly. 23. Fine. 24. Showery. 25. Cloudy: fine. 26. Stormy and wet: fine at night. 27. Rain. 28. Fine.

Penzance.—February 1. Fair: hail and snow showers. 2. Hail and snow showers. 3. Rain. 4. Showers: fair. 5. Clear. 6. Fair: rain. 7. Fair: misty. 8. Rain. 9. Misty: fair. 10. Fair. 11, 12. Misty: rain. 13. Fair: rain. 14. Misty. 15, 16. Fair: rain. 17. Fair. 18. Clear. 19. Fair. 20. Rain: fair. 21. Fair: misty. 22. Rain: fair. 23, 24. Fair. 25. Fair: rain. 26. Rain. 27. Rain: fair. 28. Fair.

Boston.—February 1. Stormy, with prodigious fall of snow. 2. Fine: snow at night. 3. Fine. 4. Rain: snow P.M. and a stormy night. 5. Snow, and stormy. 6. Fine: snow P.M. 7. Fine. 8—10. Cloudy. 11, 12. Fine. 13—15. Cloudy. 16. Fine: rain early A.M. 17. Cloudy: rain early A.M. 18, 19. Fine. 20. Cloudy: rain early A.M. 21. Fine. 22. Rain. 23. Fine. 24. Cloudy. 25, 26. Cloudy: rain early A.M. 27. Rain. 28. Fine.

Meteoro-

Meteorological Observations made by Mr. THOMPSON *at the Garden of the Horticultural Society at Chiswick, near London; by Mr.* GIDDY *at Penzance, Dr.* BURNEY *at Gosport, and Mr.* VEALL *at Boston.*

Days of Month, 1831.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	$8\frac{1}{2}$ A.M.									
Feb. 1	29·228	29·120	29·30	29·20	29·209	29·134	28·95	40	30	38	30	39	34	26	S.	NW.	SW.	SE.	...	...	...	0·630	...
2	29·334	29·189	29·20	29·15	29·332	29·182	28·95	39	13	38	31	41	32	32·5	S.	NW.	SW.	SE.	...	·75	...	·240	...
3	29·479	29·167	29·30	29·00	29·395	29·139	29·15	43	29	42	33	46	39	24·5	E.	NE.	SE.	calm	0·05	·35	1·550	·550	...
☾ 4	29·499	28·994	29·70	29·40	29·604	29·179	28·72	43	31	42	33	42	34	36	W.	NW.	W.	calm	...	·05	...	...	0·80
5	29·837	29·659	29·90	29·85	29·969	29·811	29·22	40	25	43	35	42	31	34	W.	N.	NW.	N.	...	...	...	...	·55
6	29·859	29·451	29·70	29·40	29·912	29·719	29·60	48	33	50	37	43	39	30·5	E.	SE.	SE.	calm	·10	·25	·840	·290	...
7	29·823	29·550	29·65	29·50	29·823	29·601	29·10	55	47	53	43	54	50	39	SW.	W.	SW.	calm	...	...	...	·020	·30
8	29·936	29·920	29·70	29·70	29·923	29·910	29·35	56	53	53	47	57	52	49	SW.	SW.	S.	SW.	...	·05	·365	·060	...
9	30·138	30·013	29·95	29·80	30·135	30·035	29·40	62	39	54	50	60	47	54	SW.	SW.	SW.	W.	·15	...	...	...	...
10	30·250	30·230	30·05	30·00	30·243	30·231	29·61	65	36	55	49	54	45	49	SW.	SW.	SE.	W.	...	...	...	...	...
11	30·287	30·261	30·18	30·10	30·282	30·278	29·65	59	47	54	48	54	48	47	SW.	SW.	SW.	calm	...	·02	·100	·025	...
● 12	30·302	30·310	30·20	30·15	30·293	30·280	29·75	58	41	54	48	56	47	43·5	SW.	SW.	SW.	calm	·10	·02	·105	·015	....
13	30·246	30·216	30·10	30·08	30·238	30·191	29·73	49	41	54	47	49	45	45	S.	SW.	S.	calm	...	·01	·070	·040	...
14	30·259	30·251	30·10	30·08	30·233	30·222	29·73	47	36	50	45	50	43	43	S.	S.	SE.	calm	...	...	...	...	...
15	30·150	29·946	29·90	29·86	30·088	29·923	29·70	51	37	48	45	47	44	42·5	S.	S.	SE.	calm	·10	·06	·585	·120	...
16	29·986	29·902	29·94	29·90	30·034	29·975	29·38	55	39	51	44	51	41	47	W.	W.	SW.	W.	...	·05	...	·040	·15
17	30·212	29·919	30·25	30·10	30·246	30·094	29·47	50	36	48	42	49	38	40	W.	NW.	NW.	W.	...	·01	·130	...	·02
18	30·233	30·208	30·25	30·25	30·261	30·233	29·72	48	37	50	40	51	41	42	W.	NW.	NW.	W.	·12	·01	...	·005	...
☽ 19	30·039	29·957	30·20	30·20	30·128	30·113	29·56	50	37	49	42	51	41	43	NW.	NW.	NW.	W.	...	·20	...	...	...
20	30·022	29·993	30·10	30·05	30·051	29·981	29·60	44	31	49	43	44	32	38	NE.	N.	N.	NW.	...	...	·045	...	·22
21	30·101	30·077	30·10	30·10	30·123	30·100	29·63	43	35	48	36	42	38	35	N.	N.	NW.	NW.	·16	·01	...	·060	...
22	30·344	30·069	30·10	30·05	30·303	30·038	29·63	40	32	48	40	46	32	40.5	E.	N.	NE.	calm	...	·02	·070	·010	·09
23	30·446	30·367	30·30	30·30	30·431	30·358	30·00	44	33	48	38	44	40	35	W.	W.	W.	NW.	...	·02	...	·025	...
24	30·197	30·045	30·20	30·15	30·206	30·091	29·75	50	41	53	42	52	43	41·5	S.	W.	W.	calm	·12	·01	...	·005	...
25	29·850	29·714	30·00	29·65	29·928	29·828	29·35	47	38	50	44	48	43	41	W.	W.	W.	calm	...	·05	·745	·115	·06
○ 26	29·525	29·208	29·50	29·50	29·564	29·284	28·65	55	32	51	44	53	40	44	W.	NW.	NW.	W.	...	·07	·400	·125	·16
27	29·419	29·232	29·60	29·50	29·508	29·288	28·90	55	34	53	43	53	38	39	W.	NW.	W.	calm	...	·26	·030	·010	...
28	29·753	29·567	29·80	29·70	29·818	29·661	29·11	50	35	48	45	53	35	38	W.	N.	NW.	NW.	·25	...	...	·015	·15
	30·446	28·994	30·30	29·00	30·431	29·134	29·40	65	13	55	30	60	31	39.9					1·15	2·27	5·035	2·400	2·50

J. & C. Walker Sculp.

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

MAY 1831.

XLIX. *On the Impediments to the Study of Natural History; illustrated by a Reference to certain technical and incidental Obscurities, in the Arrangement of the diurnal Family of Lepidopterous Insects, by various celebrated Naturalists.* By A Correspondent.

THE experienced naturalist will probably look upon the following observations as an unjustifiable intrusion on the columns of a purely scientific journal. But when it is considered that even Natural History itself, in its more extended sense, is viewed by the generality of the world, rather as a relaxation from severer pursuits, than as a serious study requiring all the acumen of an energetic mind,—some allowance will, it is hoped, be made for a few suggestions, having for their object the promotion of a delightful branch of science, which, to use the words of an intelligent writer, runs great risk "under the present unaccountable thirst for innovation, displayed by revolutionary zoologists" of replunging "systematic zoology into its former state of barbarism," and thus effectually excluding all but the most experienced of the superior class of an initiated few.

It is from no wish to disparage the valuable labours of authors who have devoted their whole time and attention to the perfection of science, that I venture upon the tender ground of commenting on the almost insurmountable obstacles thrown in the pathway of him who, devoting the few leisure hours he is able to deduct from the more imperative claims of life, would familiarize himself with a study from which he must, under existing circumstances, be in great measure absolutely debarred. I am fully aware of the necessity of nomenclatures and preliminary steps in the ladder to learning;

but I would wish to see that nomenclature made correct and applicable, and from its perspicuity and practicability rendered available to a far larger portion of an inquiring world than it now is; and, above all, untainted with the blighting influence of party feeling, which, although naturally and invariably identifying its pernicious spirit with the intrigues of politicians and controversialists, ought to find little encouragement in the mild and peaceful walks of Natural History. But unfortunately, even in them this unsociable intruder finds its way; and angry discussions on the comparative merits of natural and artificial systems have not only stood foremost in the warfare, but done their best to mystify points which under temperate and judicious management might have been rendered far more clear, intelligible, and satisfactory.

On the wide arena of these disputes it is not my intention now to enter. But notwithstanding the high authority of one of these contending partisans, I can by no means acquiesce in an assertion that the latter of these systems (the artificial) is "trivial and contemptible, in comparison with the smallest glimpse of the other." So far, in my humble opinion, from this being the truth, I consider an artificial system, under judicious management, to be of the highest importance; not merely on the ground of intrinsic merits, but as a stepping-stone to the more extended views of the power, the goodness, and wisdom of Providence. If an artificial system confines our knowledge to an acquaintance with individuals,—let it be recollected, that in proportion as our intimacy with individuals is enlarged and cemented, in that proportion shall we be led to form just ideas of the societies in which those individuals live, and the circles in which they move; thus ascending from particulars to those general truths, in which our knowledge may revel without restraint, approximating to, and comprehending the views of the Omnipotent Being who devised the original plan of creation.

My own opinion is, that the opponents in this incipient warfare forget, or do not take it sufficiently into consideration, that their respective systems have not of necessity an absolute connection; that they are essentially different in some very important points; and only produce mischief when they are indiscreetly brought into collision. Certainly, if either could be so far improved or purified as to supersede the other in all its theoretical and practical views, there can be no question that it ought to be adopted, to the entire exclusion of a rival less applicable to the necessities of the case: but until that event, most devoutly to be wished for, does occur, let each be valued on its own respective merits and utility; and it will not

not surely be denied that any system, however unnatural, however fanciful, arbitrary, or artificial it may be, provided it enables an unassisted and uninstructed inquirer to arrange and class and name in conformity with certain rules, any specimen he may happen to meet with,—confers no trivial boon on the scientific world; and were I inclined to probe this part of the subject very deeply, I think it would be found that in some departments, at least, of science, an artificial arrangement has an advantage over a natural system, for these reasons: —

1st. That the very term Natural arrangement implies a previous and thorough knowledge of the very subject with which the inquirer is desirous of acquainting himself.

2dly. That the very term Artificial arrangement implies a certain latitude in the adoption of certain means to definite ends. That this is a correct view of the case, the remarks of one of our greatest supporters of natural to the exclusion of artificial systems will tend to prove. "An artificial system (says Mr. MacLeay)* depends solely on observation, and may be said even to require the exercise of no other faculty than that of vision, having no other merit than the *readiness* and *facility* with which it may enable an object to be named; whereas the discovery of a natural system, being the work of an all-wise, all-powerful Deity†, can only be hoped for from a cautious process of inductive and analogical reasoning applied to facts gathered from observation." "The former," he observes, "is the miserable resource of the feeble mind of man." But surely in making so severe a remark he ought in justice to have added, that, as the latter is the plan of the creation itself, it required the ken of Omnipotence itself to fathom and apply it, and must assuredly operate as no small impediment in the way of those whose cause I am now pleading.—For one more instance of the difficulties he will have to encounter, let an inquirer be referred to the new natural system, known by the name of the *quinary*, which this eminent naturalist claims as his own; the bases of which are: 1. That all natural groups, whether kingdoms or any subdivision of them, return into themselves;—a distribution which is expressed by a diagram of five circles impinging on each other, forming, if I may so

* *Horæ Entom.* Pref. xii., xiii.

† Is it not a fallacy to say, that a Natural system is the work of the Deity, whereas an Artificial one is only the work of man? The appellation Natural System, if used synonymously with the Plan of Creation itself, is indeed the work of the Deity; but when employed to designate any attempt to unravel that plan by fallible mortals, it is evident that in reality quite a different thing is implied.—Edit.

 express

express myself, one uniting pentagonal circle. 2ndly, Each of these contributory circles is formed precisely of five groups; each of which is again resolvable into five other smaller groups; and so on, to more minute and almost indefinite subdivisions. 3rdly, That proximate circles, or larger groups, are connected by the intervention of still lesser osculating groups: and, 4thly, That there are relations of analogy between the corresponding points of contiguous circles.—Of the truth or error included in these mysterious circles I withhold the expression of opinion. But I cannot but think that the aspirant encountering them on the threshold, deserves superhuman praise if he has the courage to persevere, at the hazard of exposing himself to the fate anticipated by Linnæus,—of overturning the commodious and well-covered house of an artificial system, in order to build another in its place, the roof of which he may be incompetent to complete.

As a practical illustration of the comparative merits of these systems, let two travellers be supposed landing on a newly discovered island, abounding in rare and curious subjects of natural history; the one depending entirely on his knowledge of a natural system, the other altogether ignorant of the deeper lore of science, but possessed of a set of applicable rules, founded on a system purely artificial. I suspect, that while the former was buried in the endless and too often hopeless task of drawing conclusions from comparing a lepidopterous insect, for instance, under its trifold existence of larva, pupa, and imago, observing with unwearied attention and devotion of time its habits, propensities, and modes of life; his less gifted companion would, by a simple adherence to his mechanical nomenclature, have collected and arranged his specimens satisfactorily, and without difficulty to himself assigned class, order and genus, to each individual insect he had captured; thus preparing an ample store of interesting contributions for the cabinets of those more competent to appreciate their value.

I would in the next place briefly touch upon the impediments arising from the rapidly increasing attachment to excessive analysis. There was a time when a simple and intelligible division into class, order, genus and species, was deemed amply sufficient for all practical purposes; but those happy days have long gone by, and these primary divisions can scarcely be traced under an overwhelming accumulation of minor groupings. The trisection of an order into subsections, families and tribes, was soon succeeded by further decimations, till classification now frequently stands under the following

appalling

appalling scale of primary and subordinate characters: 1. Sub-order; 2. Section; 3. Subsection; 4. Tribe; 5. Subtribe; 6. Stirps; 7. Family; 8. Genus; 9. Subgenus.

Instances without end might be given of the increased difficulty arising from this attenuated refinement. Thus the *Eurymus Philodice*,—a butterfly closely connected with *Pap. Edusa* and some other well-known British species, and easily cognisable under the division of the *Danai candidi* of Linnæus and the Clouded Yellows of Haworth forming part of that division,—according to modern refinement is referred from Fam. *Papilionidæ* to the Juliform stirps of one author, to the subfamily *Coliadæ* of another, till it arrives at the subgenus *Eurymus*, where it is placed (if we are correct in construing another highly distinguished author's meaning,) as the only species of a strictly typical character illustrating a particular group. Again, I might quote the very language of one of our most scientific writers, who in describing a species of one of his groups (a term in itself sufficiently indefinite) is constrained to admit the force of my argument: "It is the misfortune," he observes, "of not understanding the typical structure, and the principles which regulate its variation in higher groups, that in defining the characters of a lesser, we can form no just idea of its relative value; whether, in short, we should consider it as a genus or a subgenus, or whether it is typical, aberrant, or osculant!" Here it may be further remarked, we find grouping within grouping, the very term itself in its simplest sense, being sufficiently vague and indefinite, calculated to make confusion worse confounded, or, as Fabricius—no mean authority—observed when speaking of minute investigations, endangering the study itself by "reducing it to a chaotic state." And yet the very writer whose words we have quoted, concludes his paragraph by calling it a mere temporary evil. Surely he must have forgotten his previous remark on the obscurity of definitions and descriptions,—"that in general they were so vague and short, that, unless a figure was quoted to elucidate them, it became totally impossible to ascertain the precise species intended." A remark in which I most fully concur. One other instance, and I have done:—A butterfly (we believe a solitary specimen) was found by Dr. Horsfield in Java, very closely resembling the *Papilio Jairus* of Fabricius, differing only in the form of the anterior wings; and yet on this distinctive discrepancy, the vagueness of which will be noticed below, a new genus under the arbitrary and unmeaning title of *Drusilla* has been formed.

I shall now proceed to make a few brief remarks on the vagueness of definitions, showing that notwithstanding these modern

modern and excessive refinements, little reliance can be placed upon them. Superficial readers may not perhaps be aware that most of the systems in Entomology, are made in great measure to depend on a thorough knowledge of most elaborate anatomical descriptions: "cujusque vel minimi discriminis diligentissima observatio*," the essential points depending, as in the case of Fabricius, upon such minute parts of the mouths of insects as are not visible without a compound microscope, and even then not without the most careful dissection by a skilful and accustomed hand.

But there are multitudes of cases in which all this skill and care and microscopic observation must go unrewarded. Take as an example the first entomological plate given in Swainson's valuable Zoological Illustrations, *Colias Statira*. Experienced naturalists need not be informed that the palpi of the Papilionidæ are looked upon as features of great authority in the subdivisions of the tribe; and consequently on turning to Godart†, who with some trifling variations adopts the system of Cuvier and Latreille, we find the palpi occupying the first place in ascertaining the generic character, and thus mentioned — " Genus *Colias* — Palpes inferieurs tres-comprimés; leur *dernier article beaucoup moins long* que le précédent." In strict conformity with these and other equally good authorities Mr. Swainson commences the generic character of the *Colias*, with Palpi *breves*. But on reading his description of this very first illustration of the genus; what do we find—what, but that the *last joints* of these palpi are *extraordinarily prolonged!*, and that a similar prolongation is the characteristic distinction of the *Colias Drya* of Fabricius, a totally different insect. Well may he,—in stating candidly (without blinking the difficulty) that this prolongation of a prominent generic feature is at variance with the generic character of the *Colias*,—add with equal candour, that this is a striking proof that in a natural system, no single part can be taken as an unerring criterion for generic distinction, without making it eventually an artificial one. Again; in speaking of the *Ismene Œdipodea* he remarks, that although the perfect insect possesses striking and peculiar generic characters, neither the caterpillar nor chrysalis appears to differ from others of this family of *Papilionidæ;* adding, that this is one of the many facts which prove the impossibility of making the larvæ a primary consideration in forming the genera of Lepidoptera. It may be further observed, by the by, that here, as well as in some other instances, the dissection of the mouth was omitted,

* Latreille. † *Tableau Methodique des Lepidoptères.*

for

for fear of destroying the specimen;—a very natural remark to make, and obviously applicable in nine cases out of ten, where of course the captor of a rare or to him unknown insect, would hesitate in destroying a specimen which he might not easily, if ever, have an opportunity of replacing.

We need not be surprised to find, when contending with these obscure and vague distinctions, that the most experienced entomologists are themselves bewildered; and consequently, in the arrangement of their cabinets and catalogues are not unfrequently in the habit of inserting the same insect under different genera or divisions. Sometimes it is a *Bombyx*, then a *Noctua*, then a *Geometra*, or a *Phalæna*, or some other minor subclassified title, according to the ever varying or vexatiously indeterminate state of scientific arrangement.—My last, but though last, not least charge is, respecting the extreme arbitrariness and wantonness of appellation, whether with reference to the higher or subordinate divisions. Let it not be said that on Linnæus the guilt devolves; that in classing his *Papilios* he made them into Greeks and Trojans, associated them with the Muses, the numerous progeny of Danaus and Egyptus, or the presiding nymphs of the classic world. Call it fanciful if we please, or an aberration from sound sense. Still we can forgive a fanciful deviation from rigid rules, or pardon him for that method in his madness, which after all afforded something like a clue, of which every disciple who has had the benefit of a classical education might avail himself, associating the lighter study with the deeply instilled lessons of his early days. Neither do I feel inclined to utter a syllable in the shape of railing accusation against those definitions, however harsh or crabbed, which can be yet made intelligible, by any *obvious* reference to any dead or living language, or whose etymology is rendered tangible by an association with habits, colours, or other characteristics of the object to be described. All I war against is, that unmeaning, bewildering and heterogeneous assemblage of appellations, from which no information can with the utmost stretch of ingenuity be derived, possessing all the objections to the Linnæan terms and phraseology, without their beauty and method. Take for instance, the following genera of British *Papiliones:* 1. Papilio; 2. Gonopteryx; 3. Colias; 4. Pontia; 5. Leucophasia; 6. Pieris; 7. Dioritis; 8. Nemebius; 9. Melitæa; 10. Argynnis; 11. Vanessa; 12. Cynthia; 13. Apatura; 14. Limenitis; 15. Hipparchia; 16. Thecla; 17. Lycæna; 18. Polyommatus; 19. Thymele; 20. Pamphila.—Of these, with the exception of the 1st, 2nd, 5th, and 18th, it would be

be difficult to collect the shadow of an assignable cause for the given cognomen. Of the remaining four, Papilio may be said to be rather a generally comprehensive term for the whole set, than a generic distinction for a twentieth part. For the 2nd, Gonopteryx, there is a decided and intelligible meaning in the angular character of the posterior wing. Of the 5th, Leucophasia, it may be observed that it is an intruder of very recent date, a scion separated from the genus Pontia by Mr. Stephens, with an apology stating that it is not without reluctance he adds another generic name to the almost infinite number with which the pages of entomological works are already filled. With the 18th, Polyommatus, we have no other complaint to find, than a regret that the old and more generally intelligible Linnæan term *multipunctatæ* was not adhered to.

Much very much more remains to be said, but I fear that I may already have said too much,—too much, not to expose these remarks to the reprehension of my brethren far advanced in the flights of science. Too much, to induce incipient entomologists to venture further on a study, whose real characters may be found, when further cultivated, to be repulsive or inscrutable. Most truly has the Secretary of the Linnæan Society expressed himself in saying, that "in no department in natural history are the inconveniences arising out of the confusion of analysis and synthesis more felt than in Entomology, it being worse furnished with skilful arrangement, owing to attempts which have been made to combine the natural with the artificial systems." The result, he truly adds, will finally be, that instead of making Natural History familiar and popular, it will require the compass of a man's life to master the terms we employ.

RURALIS.

L. *On the recent Change of Form of the Summit of Mont Blanc.* *By* A CORRESPONDENT.

THE pyramid which was erected on the summit of Mont Blanc in 1811, by order of Napoleon, has been described as a cross, not only by Mr. Auldjo, but also by Dr. Clark and Captain Sherwill in their account of their ascent in 1825. The fact is, that the cross was a simple pyramid, of which the following are the dimensions. It consisted of four strong posts, squared and closely joined together by eight solid iron hoops, on one of which was engraven the name of Napoleon; on the second, that of the chief engineer of the district; and on the third,

third and fourth hoop, the names of Joseph Coulet and J. Balmat (dit le Mont Blanc), the two guides of Chamouni who were charged to fix the pyramid on the summit. The posts were of a species of *Pinus* called *Melèze*, which grows in the Alps at the height of nearly seven thousand feet, and was therefore considered more likely to withstand the destructive force and change of climate on Mont Blanc. They were selected from the forest of La Blaitière, fashioned at Chamouni, and carried the first day by six men as far as the rocks called the Grands Mulets, nine thousand nine hundred feet above the level of the sea. The second day these indefatigable mountaineers arrived at the summit with their ponderous load; and having excavated a hole in the ice six feet deep, the pyramid was planted: but its elevation above the surface being only six feet, it could not be seen from the neighbouring valleys without the aid of a telescope.

As the workmen had no other materials but the fragments of ice which they had dug out of the hole with which to secure the foot of the pyramid, it was not likely it should remain long or be substantially built. It is very true that this obelisk was no longer in a perpendicular position on the third day after it had been erected, but it remained in an inclined direction towards the south-west nearly three years. When M. Rodatz of Hamburgh gained the summit in 1812, he found the pyramid still existing, and tied an empty bottle to the top of it, as is related by the guides who accompanied him.

This little incident, simple in itself, of leaving a memento on the summit of Mont Blanc, is not the only one recorded; for Dr. Clarke, in his Narrative, says, "Returning from the classic regions of Italy, it seemed a pleasant object for a walk, to place the symbol of peace at the mast-head of Europe, and deposit a little memorial of the pre-eminence of England, where it may be likely to remain for centuries unmolested. For this purpose we had gathered on the shores of the Mediterranean some branches of olive covered with bloombuds; and lest a plant reared on a land of slavery and oppression should be of unhappy augury, we had replenished our wreath with twigs of olive from the free and happy soil of Geneva: these we had inclosed in a cylinder of glass, [an empty wine bottle,] subjoining the names of some of the most remarkable persons of the age, whether high in honour as enlightened politicians, revered as sincere and eloquent theologians, admired as elegant poets, useful as laborious physicians, or adorning the walks of private life by the mingled charm of urbanity, gentleness, accomplishments or beauty. Having

reached the loftiest uncovered pinnacle of Mont Blanc towards England, the land of our hopes, we selected a little spot, sheltered from the storm by incumbent masses of granite, and there buried deep in the snow, an humble record, but sincere; hermetically sealed down by an icy plug, covered with a winter's snow, and perhaps gradually incorporated into the substance of a solid cube of ice, it may possibly remain unaltered for many centuries, like the insects preserved in amber, and so bear witness to distant generations, when other proud memorials have crumbled into dust."

But to return to our pyramid and the unexpected effect it has produced. M. de Saussure and others have described the summit of Mont Blanc as bearing the shape of a *triangular platform:* this is certainly not the case at present; for its form, as described by Dr. Clarke, is thus given from a hint offered to that gentleman by his companion Captain Sherwill: "Suppose half an orange quite covered with melted sugar on the outside, and compressed pretty strongly between the fingers, you have thus a very tolerable imitation of the extreme summit of Mont Blanc." May it not therefore be probable, that the pyramid fixed there in 1811, having been overturned by the storms, but not entirely carried away, has occasioned an accumulation of snow around it, and thus totally changed the triangular platform appearance described by the first visitors to this most elevated spot in Europe about five-and-twenty years ago? The change in the shape of the summit is more likely to be the result of the fact thus described by the falling of the pyramid, than of any simple and continued fall of snow, which latter, before it becomes hardened by alternate heat and cold, is constantly being swept from the platform by every wind that blows, and thus tends to furnish the adjacent glaciers with new matter, although perhaps in a very small degree. The writer of this article recommends to those of his countrymen who should be induced to visit this spot, to cause some of the most robust guides to search for the pyramid; for there is no reason why they should not be equally able to dig in the ice as those guides who in 1811 carried it to the summit,—and thus ascertain the truth of this proposition: but to remove any part of it or of the gentleman's bottle would be sacrilege.

Geneva, 1831. M. S.

LI. *Notice*

LI. *Notice of the Discovery of the* Plesiosaurus *in Ireland. By* James Bryce, *Jun. A.B.**

IT is well known to geologists, that the oolites,—that series of rocks which, in England, intervenes between the new red sandstone and the chalk,—are almost entirely wanting in Ireland. The only members of the formation which exist there, are the lias and the mulatto or green-sand, and these occupy but a very limited extent of surface. They appear in the escarpment of the great basaltic area, which comprehends all Antrim and half of Derry. Encircling it, the chalk, with one or two exceptions, always underlies the basalt. The mulatto generally accompanies it; but the lias is frequently absent. It occupies a narrow though unbroken zone from a few miles south of Belfast, to two miles north of Sarne,—a distance of about twenty miles; but in the remaining part of the escarpment it occurs only in detached patches of very small extent. Limited, however, as the formation is, it has been but partially examined, and until within the last few months it has not afforded any remains of the vertebrate animals, which have been found in such abundance in the same formation in England. Within that time, some vertebræ of the plesiosaurus have been discovered near Belfast.

These remains were found in the black clay of the lias which underlies the mulatto along the southern front of the low hills which connect the Cave-hill with Carnmoney-hill, at the distance of four miles north-east of Belfast. The stratum is beautifully exposed in section in a chalk quarry within a few perches of Carnmoney church;—in this quarry the vertebræ were found. Twelve of them were lying in a straight line in groups of two or three together, which were separated from one another by an interval of about a yard and a half, thus showing that they were remote parts of the same vertebral column. They were all carried off by the workmen; and with the exception of one, which after the strictest search was recovered, they were all lost. Six more were afterwards found, under such circumstances as to render it highly probable that they belonged to the same individual as the former. These seven vertebræ are now deposited in the Museum of the Belfast Academy†.

Being acquainted with the discoveries of Sir Everard Home and the Rev. W. D. Conybeare, I suspected that they belonged

* Communicated by the Author.

† They were presented to the Museum by Mr. J. H. Smythe of Carnmoney, to whom the credit of their discovery is due.

 either

either to the Ichthyosaurus or to the Plesiosaurus; but knowing no more of comparative anatomy than enabled me to comprehend the terms of a description, I had recourse to the memoirs published in the Geological Transactions, (vol. v. part ii., and second series vol. i. parts i. and ii.) by Mr. Conybeare, to whose sagacity we owe almost all our knowledge concerning these singular genera*. On comparing the vertebræ with his drawings and descriptions, it was evident that they belonged to the Plesiosaurus. Two of them are cervical, four dorsal, and one lumbar. They were recognised by being slightly concave at both ends, by the proportions which obtain between the length of the side and the diameter of the articulating surface, by small dimples in the lower part of the body, and by a slight swelling in the middle of the circular area of the end, which is largest in the dorsal, and in the lumbar does not at all exist. The spinous processes are almost entirely broken off; so much of them remains as barely to show the course of the spinal canal. The following are the proportions between the side and the diameter of the end.

Cervical.	Dorsal.	Lumbar.
$2\frac{4}{5}$ inches side.	3 inches side.	$2\frac{1}{2}$ inches side.
$3\frac{2}{5}$ inches diam.	$3\frac{1}{2}$ inches diam.	$3\frac{1}{2}$ inches diam.

These proportions are sufficient to distinguish them from the vertebræ of the Ichthyosaurus and Crocodile. But they are larger in dimensions than any which Mr. Conybeare seems to have met with, and appear to agree more nearly with those found in England in the Kimmeridge clay, than with those found in the lias.

I am informed by Dr. MacDonnell, that single vertebræ of the same kind have been found in the lias near Sarne; and in the collection of William Temrent, Esq. of this town, there is one which was obtained from the lias of Colin-glen, and which from its dimensions appears to be an extreme caudal vertebra.

The discovery of this genus in our lias connects that formation most intimately with the oolites of England and France, and affords us reason to hope that when fully examined it will, though imperfectly developed, amply reward the labour of the inquirer, by the discovery of many singular remains, which may probably, like this Plesiosaurus, supply us with new links in the chain of organic being.

Belfast Academy, March 15, 1831.

* For a full account of these genera, see the memoirs referred to in the text; or the volume "Fossils," by E. Pidgeon, Esq., in Cuvier's "Animal Kingdom," by E. Griffith, Esq., and others.

LII. *On*

LII. *On the Tides on the Coast of Great Britain.* By J. W. Lubbock, *Esq. F.R.S.**

[With a Map.]

MUCH valuable information on the subject of the tides being scattered in works relating to navigation, it may perhaps be useful to exhibit at one view in a small map the progress of the tide or high water round Great Britain, where it is better known than in any other part of the globe, the rise throughout being considerable, and therefore the time of high water easily observed. The plan of the map is taken from one in the first volume of Dr. Young's Lectures on Natural Philosophy. I hope it may tend to draw the attention of scientific men residing on the coast to this important subject, which has been hitherto so much neglected. It is to be regretted that the time of high water is not given in all maps in those few places where it is known with sufficient accuracy.

The progress of the tide round Great Britain is a striking instance how much this phænomenon is influenced by local circumstances: for while the tide in the open ocean follows the moon, proceeding from East to West; here the general direction, and particularly that of the tide up the Channel, is from West to East. The tide which arrives from the Atlantic divides into two branches; the one going up St. George's Channel, the other up the English Channel. The former meets the tide from the north-west coast of Ireland near St. John's Point on the north-east coast of Ireland, opposite the Isle of Man. The other branch proceeds up the Channel, making high water at Beachy Head, Dungeness, and Deal, at nearly the same time as at Dieppe, Boulogne and Calais. This tide appears to divide, after passing the Straits of Dover, into two branches; one of which meets the tide which comes from the North, at the sand called the Kentish Knock; the other branch makes flood tide along the opposite coasts of Flanders, Holland and Jutland, as far as the entrance of the Sleeve. The tide from the north-west coast of Ireland divides into two branches; one of which meets the tide which comes up St. George's Channel near St. John's Point, as before said; the other proceeds round the coast of Great Britain until it meets the tide which comes up the English Channel, off the Kentish Knock.

There is no perceptible tide on the opposite coast of Norway, although there is further north, as at Hammerfest and at the North Cape. The *crest* of the tide which makes high

* Communicated by the Author.

water

water at the south-western extremity of Ireland at about 5 o'clock on full and change, arrives at Calais about six hours afterwards, nearly at the same time that another branch, which proceeds round the western coasts of Ireland and Scotland, makes high water at the Orkney Islands, as may be seen in the map.

It is usual to give the time of high water *at full and change*, which is called *the establishment* of the port. This is marked in Roman figures in the accompanying map.

The time of high water at full and change is affected by the moon's parallax and declination: if therefore the time be observed at this point of the moon's age, the correction for parallax and declination should be applied with a contrary sign, in order to reduce it to some fixed standard. It would be better to give the time of high water when the moon passes the meridian at 2 o'clock, the time being then, according to theory, not so sensibly affected by parallax. It is also usual to give the height of *spring tides* and *neap tides*. These vague terms may answer the purpose of a popular explanation; but when accuracy is required, the age of the moon corresponding to the given height should be defined by the time of her transit to the nearest minute, and her parallax and declination as well as the month of the year should be stated, which circumstances have a material influence. When but few observations are made, the direction of the wind should also be remarked.

In order to determine the establishment of any port, the time of high water may be observed at different syzygies, and the mean of these observed times compared with the mean of the moon's corresponding transits. Suppose, for example, the mean of different observed times of high water at any port is five hours, and the mean of the moon's corresponding transits $0^h\ 10^m$, the establishment of the port is $4^h\ 50^m$; neglecting the influence of parallax and declination.

Many details concerning the tides on the coast of Great Britain may be found in the following works:—Directions for navigating in the North Sea, by M. J. F. Dessiou. Directions for navigating throughout the English Channel, by the same Author. And, Sailing Directions for St. George's Channel, by Messrs. T. and A. Walker.

For the reasons stated above, the times of high water at full and change given in those works can only be considered as very rough approximations, until the methods by which they have been determined are explained in detail.

The lines in the map stretching from coast to coast, are intended to represent the *crest* of the water, or what may be called cotidal lines, being the series of points where it is high water

water at the same instant. It is difficult, however, to determine the form of these lines, which are generally, no doubt, perpendicular to the direction of the current, from the want of means to determine the time of high water at sea. The times in the map are intended to be *Greenwich time;* the extent, however, included by the map, and the scale, are so small, that the differences between the Greenwich time and the time at the place, in the present state of our information is of little consequence.

LIII. *On the Reduction of the North Polar Distances of Stars observed at Greenwich, and corrected by* Bradley's *Refractions, to Distances according with* Ivory's *Refractions. By* W. Galbraith, *Esq. A.M.**

IN the construction of the following Table, it is supposed that the observations are made when the celestial objects are on the upper meridian; consequently, the zenith distances are North as far as 38°½ nearly, and South as far as 85°, where the Table of Bradley terminates in the first volume of Mr. Pond's Greenwich Observations, page v.†

The error of the refractions of Bradley at the pole is $-0''\cdot53$; that is, $0''\cdot53$ must be subtracted from polar distances, as those of the Greenwich Catalogue by Bradley's refractions, to obtain those by Ivory's. The French refractions, as well as those of Brinkley and Bessel, differ but slightly from those of Ivory at moderate zenith distances; consequently the Table will also give the results from these tables very nearly.

As the corrections were computed when the barometer is supposed at 30 inches, and the thermometer at 50° Fahrenheit, there will be a slight difference if the barometer and thermometer deviate greatly from these, though in all ordinary cases the error from this cause will be very slight, since the correction is only a small relative quantity. Such a table as this is alluded to by Mr. Pond in page 237, but has not, so far as I am aware, been any where published. The difference, indeed, never much exceeds $1''\frac{1}{2}$ till about 83° zenith distance, and at 85° it is not less than $6''\frac{1}{2}$, though, no doubt, observations when great accuracy is required will not be made at such low altitudes.

From the peculiar mode of observing by the mural circle as used at Greenwich, some other consequences would be elicited;

* Communicated by the Author.

† It may be remarked here, that the logarithms of the factor for the English barometer in page xi. to reduce the French table for pressure, are all slightly erroneous by supposing $0^{m}\cdot76 = 29^{in}\cdot94$ instead of 29·922.

elicited; but these may be reserved for another communication. The use of the present Table may be shown by the following examples.

Example 1.—Required the mean place of Polaris on the 1st of January 1830 from the Greenwich Catalogue, allowance being made for the difference between Ivory's and Bradley's refractions, the latter being those by which its mean place was deduced.

	°	′	″
Polaris N. P. D. by Nautical Almanac 1830	1	35	51·40
Correction of this by the table................	—		0·53
Mean place by Ivory's refractions...........	1	35	50·87

Example 2.—Required the mean place of Spica Virginis, January 1, 1830.

	°	′	″
By Nautical Almanac N. P. D.	100	16	13·10
Correction of this by the table	+		1·16
Mean place by Ivory's refractions.........	100	16	14·26
Or, Declination..................................	10	16	14·26 S.
Decl. from Bessel (Encke's Ephemeris)...	10	16	17·88 S.
Difference less than Bessel's	—		3·62
Difference without the correction	—		4·78

Example 3.—Required the mean place of Antaros, January 1, 1830.

	°	′	″
By Nautical Almanac 1830, N. P. D......	116	2	43·30
Correction from the table......................	+		1·60
Mean place by Ivory's refractions.........	116	2	44·90
Declination..	26	2	44·90 S.
Decl. by Bessel	26	2	49·25 S.
Difference after correction....................	—		4·35
——— without correction	—		5·95

Whether corrected or not, these discrepancies appear not a little surprising in the present state of astronomy.

It will also appear that by the usual mode of determining latitudes by means of the zenith distance, if the object observed be to the north of the zenith of Greenwich, the latitude would be too small; if to the south, the declination being also south, it would be too great by the amount of the error in the place of the celestial object. Hence if extreme accuracy be required in deducing latitudes, &c. the mean north polar distance of the stars in the Greenwich Catalogue should always be corrected by this table, or by some similar means.

TABLE for reducing the North Polar Distances of Stars observed at Greenwich, and corrected by the refractions of Dr. Bradley to the results which would be obtained by the more accurate refractions of Mr. Ivory.

Barometer 30in. Fahr. Thermometer 50°.

N.P.D.	Z.D.N.	Red.	N.P.D.	Z.D.S.	Red.	N.P.D.	Z.D.S.	Red.
°	°	″	°	°	″	°	°	″
0	38½	−0·53	42	3½	+0·03	84	45½	+0·71
1	37½	0·51	43	4½	0·04	85	46½	0·74
2	36½	0·49	44	5½	0·06	86	47½	0·76
3	35½	0·47	45	6½	0·07	87	48½	0·79
4	34½	0·46	46	7½	0·09	88	49½	0·82
5	33½	0·45	47	8½	0·11	89	50½	0·85
6	32½	0·43	48	9½	0·12	90	51½	0·87
7	31½	0·42	49	10½	0·13	91	52½	0·88
8	30½	0·40	50	11½	0·13	92	53½	0·89
9	29½	0·38	51	12½	0·15	93	54½	0·93
10	28½	0·36	52	13½	0·18	94	55½	0·98
11	27½	0·35	53	14½	0·19	95	56½	1·03
12	26½	0·34	54	15½	0·20	96	57½	1·05
13	25½	0·33	55	16½	0·22	97	58½	1·07
14	24½	0·29	56	17½	0·23	98	59½	1·09
15	23½	0·28	57	18½	0·24	99	60½	1·12
16	22½	0·28	58	19½	0·25	100	61½	1·16
17	21½	0·27	59	20½	0·26	101	62½	1·19
18	20½	0·26	60	21½	0·27	102	63½	1.22
19	19½	0·25	61	22½	0·28	103	64½	1·27
20	18½	0·24	62	23½	0·28	104	65½	1·33
21	17½	0·23	63	24½	0·29	105	66½	1.37
22	16½	0·22	64	25½	0·30	106	67½	1.41
23	15½	0·20	65	26½	0·33	107	68½	1·49
24	14½	0·19	66	27½	0·34	108	69½	1·54
25	13½	0·18	67	28½	0·35	109	70½	1·58
26	12½	0·16	68	29½	0·36	110	71½	1·61
27	11½	0·14	69	30½	0·38	111	72½	1·64
28	10½	0·13	70	31½	0·40	112	73½	1·66
29	9½	0·12	71	32½	0·42	113	74½	1·68
30	8½	0·11	72	33½	0·44	114	75½	1·67
31	7½	0·09	73	34½	0·45	115	76½	1·65
32	6½	0·07	74	35½	0·47	116	77½	1·60
33	5½	0·06	75	36½	0·49	117	78½	1·50
34	4½	0·04	76	37½	0·51	118	79½	1·28
35	3½	0·03	77	38½	0·53	119	80½	0·98
36	2½	0·02	78	39½	0·54	120	81½	+ ·33
37	1½	0·01	79	40½	0·56	121	82½	− ·64
38	N. 0½	—	80	41½	0·58	122	83½	2·17
39	S. 0½	+	81	42½	0.59	123	84½	4·68
40	1½	0·01	82	43½	0·62	123½	85	6·67
41	2½	0·02	83	44½	0·65			

54, South Bridge, Edinburgh,
14th March 1831.

WM. GALBRAITH.

LIV. *On the Effect of a Change of Polar Distance on the Reduction to the Meridian of a Zenith Distance observed out of the Meridian.* By A Correspondent.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I TROUBLE you with a few lines on the effect of a change of polar distance on the reduction to the meridian of a zenith distance observed out of the meridian. Retaining the symbols used in a paper in your last Number, where Δ and Z are understood to refer to the time of meridian transit; let us suppose that for the hour angle P we have the polar distance $= \Delta + \delta\Delta$, and the zenith distance $Z + x$. The correction x to be applied to the zenith distance $Z+x$, in order to obtain Z, the zenith distance on the meridian is to be found from these two equations:

$$\sin L \cos \Delta \qquad + \cos L \sin \Delta \qquad = \cos Z$$

$$\sin L \cos(\Delta + \delta\Delta) + \cos L \,.\, \sin(\Delta + \delta\Delta) \cos P = \cos(Z + x)$$

Considering the square of $\delta\Delta$ and x^3 as evanescent, we shall find

$$x = \frac{\cos L . \sin \Delta}{\sin Z} 2 \sin \tfrac{1}{2} P^2 - \frac{\cos L^2 \sin^2 \Delta}{\sin^2 Z} \text{cotang}\, Z\, 2 \sin \tfrac{1}{2} P^4$$

$$+ \delta\Delta \left(1 + \frac{\cos L \cos \Delta}{\sin Z} 2 \sin \tfrac{1}{2} P^2 \,\&c.\right)$$

The part $\delta\Delta$ is owing to the change of polar distance, which from $\Delta + \delta\Delta$ at the time P of the observation, is become Δ at the time of the body's transit over the meridian, and

$\delta\Delta \dfrac{\cos L \cos \Delta}{\sin Z} . 2 \sin \tfrac{1}{2} P^2$ is the increase of the first term of the value of x by the substitution of $\Delta + \delta\Delta$ for Δ, as that term belongs to a polar distance Δ; whereas the real polar distance belonging to the hour angle P was $\Delta + \delta\Delta$.

The equation may be thus written:

$$x = \frac{\cos L . \sin(\Delta + \delta\Delta)}{\sin Z} . 2 \sin \tfrac{1}{2} P^2 - \cos \frac{L^2 \sin(\Delta + \delta\Delta)^2}{\sin Z^2} 2 \sin \tfrac{1}{2} P^4 + \delta\Delta$$

The correction of x depending on $\delta\Delta$ is hardly ever required; but the preceding formula shows how easy it is to take it into account.

LV. *Ob-*

LV. *Observations relative to the Origin and History of the Bushmen.* By ANDREW SMITH, *M.D. M.W.S. &c.*

[Continued from page 200.]

FOR subsistence, the Bushmen, as has already been observed, trust principally to the fruits of the earth, and to the game which their plains afford: but when either of those are found deficient, few have any hesitation in supplying their wants from the flocks of the neighbouring farmers. With even such a variety of resources, they are nevertheless often sufferers from extreme want, and are thereby necessitated to consume almost every article which is to be found within the range of their retreats. Of the vegetable productions, many roots, both fibrous, fleshy, and bulbous, form articles of their food; and of berries and other fruits, they employ almost all that are met with whose qualities are not prejudicial to health, and many of which are doubtless possessed of no properties beyond those of filling and distending the stomach. Amongst the most useful and nutritious of the vegetable products, is the seed of a species of grass which grows in their country, as well as in the northern parts of the colony, and which, when cleaned and boiled, has considerable resemblance in taste to barley similarly prepared. This at the proper season occurs in considerable quantities, and is acquired in two ways,—either by directly collecting the tops of the grass and then separating the seed, or by robbing the black ants which there occur, and who carry quantities of it as food to their subterranean abodes.

Subservient as the vegetable kingdom is thus rendered, the animal one is made not less so; for, from the largest quadrupeds that inhabit their wastes, to the most disgusting reptile or the smallest insect, almost all are in some way or other employed as articles of provision. The hippopotami, zebras, quaggas, different species of antelopes, jackals, &c. as well as the ostrich and bustard, form the favourite objects of pursuit with the men; and the pursuit of the hares, dassies, moles, rats, snakes, lizards, grasshoppers, ants, and such like forms, the occupation of the women and boys. There is scarcely a four-footed animal which they can destroy that they do not convert to food, and there is hardly a portion of any one of those, with the exception of the bones, that they do not devour. The flesh in every situation they greedily consume; the stomach and intestines they esteem as delicacies; the liver and kidneys they often swallow even raw, and the contents of the stomachs of many animals they drink or eat either pure or diluted with water. The blood of most animals they highly prize, and though usually cooked before it

it is used, yet it is often, either from choice or necessity occasioned by a want of water, swallowed as it flows from the body. The skins, at least of the larger animals, are not even rejected, and those they often feed upon with a degree of rapacity, which nothing but extreme hunger would support.

Some of the articles just stated are regularly made use of in their natural state, but the majority only when cooked. The vegetable productions that require such preparation, are either boiled or roasted; and those belonging to the animal kingdom are mostly treated in the latter way, with the exception of grasshoppers, larvæ of ants, and ostrich eggs, which are commonly consumed without being submitted to the influence of cooking; all the others are, when choice can be exercised, more or less prepared; and what requires most labour, is the dried skins of the larger animals. Those are first moistened by water, and then stamped and roasted; or else roasted first, and stamped afterwards. Though the employment of articles like the last mentioned is calculated to create a degree of wonder in those who have never suffered severely from the pangs of want, yet how much more adapted for such a purpose is the observance of a fact, which almost daily occurs amongst the Bushmen,—namely, the preparation of pieces of old shoes, &c. for the purpose of furnishing a scanty and tasteless meal.

The vegetable products are principally obtained without much labour; and if we except the different roots, few require much exertion. The latter it is necessary to dig out of the ground, and for that purpose they employ either a piece of pointed wood hardened by having been previously a little burnt, or else a gemsbok horn, and by either of those they loosen the surrounding soil with amazing rapidity. The animal productions are partly procured without much trouble, but the majority not without very considerable exertion, as well as the exercise of no small degree of dexterity and cunning. The bow and arrow are the means upon which they mostly rely for obtaining the latter; and next to those, snares and dogs. In employing the former, they either endeavour to approach the animal within a suitable distance to wound him severely, or else to conceal themselves so as to be in the way as he may be pursuing his progress, or, lastly, by the practice of decoys to bring him into a fitting position. The facility they have of creeping, and the similarity between the colour of their skin and the arid wastes over which they hunt, when conjoined to the amazing sharpness of their sight, enable them often to advance within a very little distance of game, and often by a wound of a poisoned arrow to intimate to the animal its unfortunate situation. He observes every motion of its

its head during his approach, and whenever it is possible for its range of vision to extend to him, he remains most perfectly quiet; but when that is not the case, he advances with circumspection, and is sustained by such patience, that he will sometimes pass a whole day in the pursuit, without any particular prospect of success. When again he adopts the second plan, he remarks the direction the animal is following, and the position of the best vegetation in the quarter towards which he is proceeding; and having fully satisfied himself as to its probable course, he digs a hole in the ground, and there conceals himself till fate determines what shall be the result. The third mode, or that by decoys, is practised generally with success where the requisites for forming such are procurable. They are principally, if not invariably, executed through the instrumentality of young animals, which, when obtained, are fixed a little way in advance of a low bush fence, behind which the hunter is secreted, and from whence he destroys the dam, as she visits her offspring. Another description of plan he follows, and one not less successful, in hunting the ostrich,—namely, that of digging a hole close to a nest, and concealing himself therein. When in that position, and having previously provided himself with a dog, he throws it upon the eggs; and as soon as the bird sees the animal in that position, it hastens to the spot to drive him away, when it instantly falls a victim to the ingenuity of its betrayer.

Snares they construct in various ways, and by such they often greatly increase their supplies. Some are formed of nooses placed in positions through which animals are accustomed to pass, and others consist of large and deep holes dug in the ground, and so covered over with grass and other articles as not to be distinguishable from the surrounding parts till discomposed by the steps of a visitor, when it is usually too late to discover the fraud. By this method, when practised in situations where water or grazing ground occurs, sea-cows, zebras, quaggas, and various of the antelope species, are frequently obtained. By the formation of trenches or long narrow ditches, grasshoppers are also commonly entrapped, particularly when driven in great abundance towards them, as when they fall therein they are totally unable to escape again. The resort of the white ants they discover by observing the hole at which they enter the ground; and when that is accomplished, and the object is to secure the young, they dig away the earth till the nest is discovered, when it is immediately exposed, and the larvæ, as well as many of the older specimens, are selected. In the pursuit of these, they often dig holes several feet in depth, and three or four in diameter; and after

that,

that, they are not unfrequently disappointed of the objects in view. When, however, they are successful, they carry the fruits thereof to their temporary residence, and there, by the assistance of a small piece of dried skin, remove all the earth and other impurities, after which they either devour the remainder, or else place them in a pot upon the fire and warm it a little; during which time they keep agitating the contents, so as to prevent them from burning, &c. After a few minutes of such treatment, they are considered as prepared and adapted for food. In this state they are not unpalatable, and it is only the knowledge of their nature that gives anything like a disinclination to relish them.

By the Bushmen, the food under consideration is highly esteemed, and that and the ostrich egg are perhaps the most admired articles of their subsistence. After what has been stated as to the variety of articles employed in diet, it will doubtless appear a little strange, that on many occasions they are scarcely able to exist. Such evidently arises from the scantiness with which the varieties alluded to are distributed, particularly at certain seasons, as well as from the difficulty with which many of them are obtained. It matters little, however, what the cause or causes are, as the fact is established, and is what doubtless induces them to plunder both the colonists and their various Hottentot neighbours. Lest, however, this remark should be construed as expressing my belief, that unavoidable want is the only incentive to plunder, I may observe, that I am quite convinced that laziness and a love of animal food are very often what alone urge them to thieving. [To be continued.]

LVI. *Notices respecting New Books.*

Illustrations of the Geology of Yorkshire; or a Description of the Strata and Organic Remains of the Yorkshire Coast: accompanied by a Geological Map, Sections, and Plates of the Fossil Plants and Animals. By John Phillips, *F.G.S.*, Keeper of the Museum of the Yorkshire Philosophical Society, &c. *York*, 1829, 4to. pp. 192. *Twenty-four Lithographs.*

GEOLOGY naturally divides itself into two branches, according as its cultivators study the crystalline aggregates or the stratified deposits which combine to form the crust of the earth; and accordingly we have always had two distinct classes of geologists. For the examination of Plutonic rocks, Mineralogy is required; for the Neptunian deposits we must refer to the sciences of Botany and Zoology. The most brilliant discoveries, the most striking and most successful generalizations with respect to the structure of the earth, which have yet been made, have originated in the study of organic

ganic remains. The thousands of extinct animals and plants, which fill the dark mansions of the earth, yield to the geologist as sure a record of the revolutions by which our planet, after it had become a mass of mere mineral matter, was prepared for the habitation of man, as the mummy and the pyramid, the coin and the urn, the inscription and the column, declare the subsequent vicissitudes of human society. By announcing, forty years since, the important fact that each suite of analogous strata,—the result of a peculiar set of natural operations, —contains a peculiar suite of organic reliquiæ, derived from the beings then living in the waters, or transported thither from the land, and consequently that the different fossil species of plants, corals, shells, and vertebrated remains, belong to different epochs, and mark the successive periods of the earth's formation, Mr. W. Smith changed entirely the whole face of geological science. His principles, successfully applied to determine the stratification of England, received a splendid confirmation from the researches of Cuvier and Brongniart in France, and are at this moment universally admitted as the basis of the laborious researches by which Buckland, Sedgwick, Murchison, Lyell, De Beaumont, Von Buch, Voltz, Dufresnoy, Deshayes, Necker, Brocchi, and others, have established the general accordance with each other of the stratified deposits of Europe, and the existence of more or less perfectly analogous deposits over all the world.

Mr. Smith's map of the strata of England and Wales, published in 1815, but prepared as early as 1800, will long remain a venerable monument of the then state of knowledge on that subject. And if the amiable and excellent author, oppressed less by age than by heavy afflictions, has been so regardless of his reputation as to neglect the corrections of his noble work which his own unwearied investigations have furnished, is there one among the more eager and more fortunate aspirants after such fame, so ungrateful for the light which guides his steps as to reproach the modest self-oblivion of the father of English geology?

Townsend, in his character of Moses, published, with a slight acknowledgement, what he had learned from his friend "*Stratum Smith.*" Farey's Derbyshire contains a similar abstract; and Mr. Smith's own publications have partially exposed in print those views which were the theme of all his conversations.

The author of the present publication, the nephew and pupil of Mr. Smith, has dedicated to him a performance calculated in a remarkable degree to develope and confirm his opinions. We have long intended to give this work a degree of attention in our pages in some respect corresponding to its merits, although they have been repeatedly recorded in them by Mr. De la Beche, Professor Sedgwick, and other geologists. The present time, when the Geological Society has awarded to Mr. Smith the first Wollaston medal, for his discovery of the means of identifying strata by organic remains; and when the late President of the Society has exposed in so luminous a manner the benefits which Geology has derived from his researches, in an address officially delivered from the Chair,—cannot but be appropriate for recalling Mr. Phillips's work to the attention of the public.

The

The organic reliquiæ of the Yorkshire coast have been for a long time celebrated; and the most distinguished geologists of England have employed themselves in investigating the relations of the strata, there exposed in the sea cliffs and inland ranges of hills. But though in these researches a certain part of the history of the strata was determined, and represented on Mr. Smith's and Mr. Greenough's maps, and described by Messrs. Conybeare and Sedgwick, still the whole district was most imperfectly known, and the oolitic series in particular was not at all understood. In 1822, the Rev. G. Young and Mr. John Bird, residing at Whitby, published a volume of observations on the subject containing some good descriptions, but altogether destitute of zoological accuracy and sound geological generalization, and consequently leaving the stratification of the Yorkshire coast in greater obscurity than ever. To remedy this state of things, by disclosing the true history and relations of the several rocks and their imbedded organic remains, is the object of Mr. Phillips's work.

The first chapter is an essay on the Principles of Geology, and contains a condensed view of the discoveries respecting the structure of the earth, which have produced the modern practical system of geology. This is a necessary introduction to the subsequent discussions; for, though no science in modern times has made greater progress than geology, its zealous cultivators are not numerous, and few of the persons likely to possess this book would be supposed familiar with its real principles. The general laws relating to the stratification of the crust of the earth, the distinctions of primary, secondary and independent rocks, the distribution of organic remains in the earth, and their relations to the existing races of animals and plants, the effects of internal convulsions in the earth during the deposition of the strata, are successively considered. Next follow observations on the changes which the surface of the dry land has undergone by the agency of ancient floods. In this part of his work Mr. Phillips avows himself very decidedly opposed to that part of the Huttonian theory of the earth which ascribes the excavation of valleys to the streams which now run down them, and agrees with Dr. Buckland and Mr. Conybeare in their opinion, that the same great flood of waters which destroyed so many of the land animals of the ancient world was the principal agent in producing the present inequalities of the earth's surface. The modern changes occasioned by the action of water in the sea, rivers and streams, on the ancient framework of the earth, are next sketched, and the whole terminates in a bold and striking summary view of the series of changes which appear to have visited the earth, from the period of its earliest physical condition, of which induction from known facts furnishes any indications.

"Having thus traced the outlines of a practical system of geology, I shall conclude with a very brief sketch of the series of changes which appear to have visited the earth. From chemical researches it seems highly probable that the whole crust of the earth is to be viewed as originally produced by oxidation of fluid metals and metalloids. From a careful study of the effects of heat, under different circumstances, and of the habitudes of earthy compounds under its influence, it seems probable

probable that the granitic rocks, which are the lowest of the primary series, owe their present condition and appearance to the effect of partial or general fusion. Above this granitic series we find, certainly, the effects of deep and overruling water. Many of the primary, and all of the secondary rocks owe their present appearances and arrangements to the action of water. These strata exhibit the results both of agitated and of tranquil waters,—mechanical aggregates,—sedimentary deposits,—and chemical precipitates, in frequent repetition. This circumstance, combined with the facts relating to organic remains, teaches us, that during a long period the sea flowed rich in living beings over rocks which contain no reliques of life. At times tranquil, at intervals tumultuous, this ocean, perhaps of elevated temperature, even in the northernmost regions, varied its deposits at different periods, yet preserved among them a general conformity of arrangement, from the oldest to the most recent, and a similarity over large regions. The aquatic animals and other remains, which are entombed in the earth, exhibit a long series of beings, whose origin dates from some of the earliest strata, and whose forms, differing according to the antiquity of the rocks, successively come nearer and nearer to the modern productions of the land and the ocean. During this process, at intervals, vegetable forests swept into estuaries, or lakes, furnished the materials of coal, and the intermitting action of submarine volcanoes frequently broke the consolidated strata, and formed basaltic and other overlying rocks. At times, too, more violent exertions, probably of the same cause, uplifted groups and ranges of mountains with great disruption and dislocation. Operations of the same kind are to this day continued, but so feebly*, that we commonly speak as if the causes which concurred to produce the crust of our planet had ceased to exist. They appear, however, to have been gradually weakened; and when the last series of the secondary beds, partly marine, partly lacustrine, was deposited, a large portion of pre-consolidated rocks became tenanted by land animals. But again the waters returned and overflowed the inhabited world; removed rocks, excavated valleys, and destroyed the terrestrial inhabitants, from whose anatomical construction, as displayed in their remains, it may be inferred that the antediluvian face of the earth was like our own, diversified by lakes, and forests, and mountains.

"This transient flood retires from the desolated continents; again the forest is clothed with foliage; birds fly in air, and animals roam the earth; the mountains gather clouds, rain falls, the streams flow down their new channels, the sea resumes its appointed boundary; cliffs are wasted, low shores are extended, valleys are filled up, volcanoes are in action; nature revives again, and man, by contemplation of the phænomena, reads the awful history of his birth-place, gathers ideas of the immense agency exerted in the construction of the earth, compares this planet with the other members of the solar system, and views the solar system itself as only a small part of the immeasurable works of God!"

* ——— Absumptis per longum viribus ævum.

This part of the work is clear and methodical, and agrees with the most generally received opinions of English geologists.

The evidence adduced in support of Dr. Buckland's diluvial theory deserves particular attention; and if the author has rather exceeded what his evidence will warrant, when he says "the deluge covered the whole earth," he has certainly imposed a serious difficulty on those who deny that such a flood has overswept the hills of England.

In Chapter II. we find the following tabular view of the series of Yorkshire strata.

"*Tabular View of the Series of Yorkshire Strata.*

		Utmost Thickness. *Feet.*	
Chalk formation.	1 White Chalk	500	The Wold hills from Flamborough to Hessle.
	2 Red Chalk	5	
Clay vale formation. (Smith.)	3 Gault ?	150 ?	Speeton, Knapton. Kirby-Moorside, Helmsley, Settrington, Elloughton.
	4 Kimmeridge clay		
Coralline oolite formation.	5 Upper calcareous grit	60	Silpho Brow, Sinnington, Wass Bank.
	6 Coralline oolite	60	Scarborough Castle, Pickering, Malton.
	7 Lower calcareous grit	80	Scarborough Castle, Hambleton end, Malton, Leavening.
	8 Oxford clay	150	Scarborough Castle, Saltergate Brow, Rievaulx Abbey.
	9 Kelloways rock	40	Scarborough Castle, Hackness, Rievaulx Abbey.
Bath oolite formation.	10 Cornbrash limestone	5	Gristhorpe, Scarborough.
	11 Upper sandstone, shale, and coal	200	Gristhorpe, Scalby.
	12 Impure limestone, (Oolite of Bath.)	30	Gristhorpe, White Nab, Cloughton Wyke, Hawsker.
	13 Lower sandstone, shale, and coal.	500	Cloughton, Peak, Burton Head, &c.
	14 Ferruginous beds, (Inferior oolite of Somersetshire.)	60	Peak, Whitby, Boulby, the Cleveland hills.
Lias formation.	15 Upper lias shale	200	Cliffs near Whitby, Hills near Guisbrough, &c.
	16 Marlstone series	150	Cliffs near Staiths, Head of Bilsdale, Eston Nab, &c.
	17 Lower lias shale	500	Robin Hood's Bay, Boulby, Redcar.

New

		Feet.	
New red sandstone formation. (Werner.)	18 Red marl and red sandstone.	Thickness unknown.	Yarm, Boroughbridge, and Ferrybridge.
	19 Brotherton limestone	45	From Brotherton to Doncaster.
	19 Red clay and gypsum	50	Fairburn, Knottingley.
	19 Magnesian limestone	120	Catterick, Knaresborough, Doncaster, &c.
Carboniferous formation.	20 Coal measures	2000	Leeds, Barnsley, Sheffield.
	21 Mountain limestone series	2000	Swaledale, Yoredale, and Wharfdale.
Slate formation.	22 Slate rocks	Thickness unknown.	Ingleton, Sedburgh.

Over these strata is spread the detritus of the deluge, and in particular places this is covered by more recent accumulations of peat, clay, &c.

"The eastern part of Yorkshire may be topographically considered in five divisions. Three of these are conspicuous from their elevation; viz. the open round-fronted wolds of chalk in the south, the flat-topped ranges of oolite in the middle, and the more mountainous groups of shale, sandstone, limestone, and coal, which form the northern moorlands; two are wide, level tracts: viz. the vale of Pickering, which separates the chalk wolds from the oolitic hills, and Holderness, which is a broad tract of alluvial marshland, undulated by hills of diluvial clay and gravel.

"These five divisions of the surface reach the coast in succession, and mark it with very characteristic features. The shore of Holderness is, like the interior, low and undulated; the wolds terminate in long, lofty, and connected cliffs; a depression on the coast marks the line of the vale of Pickering; flat-topped heights characterize the oolitic formation on the shore, as well as in the interior; and the highest precipices on the coast belong to the same series of rocks as the loftiest of the inland hills."

"*The Moorland District.*

"This district is remarkable for presenting, along its whole outline, a range of bold and steep escarpments. Its overhanging cliffs, which so strikingly characterize the coast between Scarborough and Redcar, are among the loftiest in Britain; and where it turns inland from Huntcliff, by Rosebury Topping, Burton Head, Dromanby Bank, and Osmotherly moors, it maintains the same high and precipitous aspect, and looks over the plain of Cleveland and Mowbray, as the ranges of Cleeve and Broadway overlook the vales of Gloucestershire. This similarity of appearance is owing to analogy of geological structure. The wide vales of Gloucestershire are, like the vale of Cleveland, based on red marl and lias shale; and the oolitic rocks of Cleeve and Broadway are represented, though with great variations, by the rocks of the corresponding escarpments in Yorkshire."

 "In

"In the following table, they are numbered according to the general series of Yorkshire strata, pages 32, 33.

	Greatest observed Thickness. *Feet.*		
Carboniferous and oolitic formation.	6	10	Impure, sometimes oolitic limestone, full of shells. (The *cornbrash* of geologists.)
	200	11	Sandstone, shale, ironstone, and coal, with carbonized wood, ferns, and other fossil plants.
	30	12	Impure, often oolitic limestone and ironstone, with many fossil shells. (*Oolite* of Bath.)
	500	13	Sandstone, shale, and coal, with carbonized fossil plants.
	60	14	Subcalcareous, irony sandstone, often containing shells, called *dogger*. (*Inferior oolite* of Somersetshire.)
Lias formation.	200	15	Upper lias shale, or alum shale, with nodules of argillaceous limestone, ammonites, belemnites, &c. (*Blue marl* of Northamptonshire.)
	150	16	Ironstone and sandstone strata, with terebratulæ, pectines, cardia, aviculæ, &c. (*Marlstone* of Northamptonshire, &c.)
	500	17	Lower lias shale, with gryphææ, pinnæ, plagiostomæ, &c. (*Lias shale* of Somersetshire)."

On comparing this section and the enlarged descriptions of the lias and oolitic formations of Yorkshire with that of the vicinity of Bath, we obtain the following important conclusions:

1st. That the calcareous portion of the lias of Yorkshire is much less decidedly accumulated into solid limestone rock than about Bath, and in this respect the Lincolnshire lias possesses an intermediate character.

2dly. That the marlstone beds, which, though well distinguished by Smith, seldom appear in much force near Bath, and then only twenty feet below the sand of the inferior oolite, are in Rutlandshire buried one hundred feet below that rock, and are covered in Yorkshire by a thickness of two hundred feet of alum shale.

3dly. That the yellow or brown sand and sandstone, which near Bath separates the inferior oolite from the lias, is continuous through the counties of Rutland and Lincoln into Yorkshire, where it is scarcely accompanied by any trace of oolite.

4thly. That instead of the shelly calcareo-argillaceous series (*Fullers-earth beds,* Smith) of beds which divides the Bath oolite into great or upper and lower, or ferruginous oolite, the Yorkshire hills contain fully five hundred feet of sandstone and shale with a vast variety of fossil plants, and thin seams of *coal;* and that between the great oolite and the cornbrash, a similar interposition of sandstone shale and coal-plants is repeated. The Bath oolite formation is therefore in Yorkshire a true coal-field, and must never be left out of consideration in any speculations on the origin of coal seams.

Mr. Murchison's researches in Sutherland show how far northward this coal-field reaches, and there are several similar examples in Germany;

many; but to the south its extent is very small, for as the oolites thicken towards Lincolnshire, the sandstone and shale are attenuated.

"Having thus noticed, in general terms," Mr. Phillips observes, "the characters of the carboniferous and oolitic formation, it remains to state, that of this whole series, which measures, in some places, not less than seven hundred feet in thickness, no part whatever is continued across the Humber, except the calcareous strata. Indeed, I am in doubt whether any portion of the sandstones, shales, and coal, is prolonged to the south so far as the river Derwent."

"If we were to put out of consideration the shelly beds of limestone, which alternate with them, we should find in these carboniferous rocks much resemblance to that more ancient deposit of coal, and sandstone, and shale, which has been expressly called the coal formation. But still we are furnished with the most satisfactory means of discrimination, in the plants which accompany the coal: for though, perhaps, one hundred species of fossil plants have been discovered in the west-riding coal-field, and not less than fifty in the sandstones and shales of the north-eastern coast; it is not too bold an assertion to affirm, that no one species has yet been found which is common to both situations.

"*The Tabular Oolitic Hills.*

"These hills meet the sea-coast between Filey and Scarborough on the east. They rise toward the north from under the vale of Pickering, and terminate in a remarkable line of escarpments at Silpho Brow, Blakehoe Topping, Saltergate, Lestingham, Easterside, and Black Hambleton. From the vale of Pickering the ascent to them is long and gradual, but from the northern moors it is very short and abrupt. The altitude of the hills increases westward. Thus, Gristhorpe cliffs are about two hundred and seventy feet high; Oliver's mount, four hundred and ninety feet; the heights above Troutbeck, six hundred and fifty feet; above Rievaulx Abbey, eight hundred feet; and at Hambleton, twelve hundred and forty-six feet. Even at considerable distances, the plane summits and abrupt terminations of these oolitic hills are very remarkable."

"It [the district] includes the following strata:

Coralline oolite formation.	Summits and edges of the tabular hills.	5 Upper calcareous grit, containing fossils resembling those in No. 7.
		6 Coralline oolite, marked by corals, echini, plagiostomæ, melaniæ, &c.
		7 Lower calcareous grit; pinnæ, gryphææ, ammonites, &c.
	Slopes of the same hills.	8 Gray argillaceous earth, containing many fossils at the bottom. (Oxford clay of the south.)
		9 Ferruginous or argillaceous sandstone, with remarkable gryphææ, ammonites, &c. (Kelloways rock of the south.)"

The upper calcareous grit was first noticed and described by Mr. Phillips in his paper in the Phil. Mag. and Annals for April 1828.

"Whoever

"Whoever compares this series of strata with the coralline oolite formation in Berkshire and Wiltshire, will find them extremely similar in the mode of arrangement, in mineralogical composition, and organic contents. The features which they impart to the country are much alike in both districts, and the whole evidence in favour of their affinity is complete and satisfactory. Yet the two districts lie wide asunder, and in all the intermediate tract a great portion of the series is unknown. From Acklam to the neighbourhood of Oxford, no coralline oolite or calcareous grit appears at the surface, (unless the limestone before mentioned in Lincolnshire, belongs to these rocks,) and the Kelloways rock has not yet been described between Huntingdonshire and the Humber. This should teach us not to undervalue the evidence of organic remains, for these are always useful and often necessary guides to determine the affinities of detached portions of the strata; and, when viewed in combination with the substance and arrangement of the rocks, the results to which they lead may be confidently adopted."

We quote the principal part of the notice of the vale of Pickering, on account of the difference of opinion between the author and Professor Buckland, respecting the value of the existing evidence of its former condition.

"Professor Buckland, in his admirable work, the *Reliquiæ Diluvianæ*, seems to admit the probability of the vale of Pickering having been an antediluvian lake, which was drained when the present outlet at Malton was effected by the waters of the deluge.

"The idea of its having been a lake naturally offers itself to every one who considers its wide level surface, and remarks the multitude of streams which run into it, and pass out by the single channel of the Derwent. But I do not think that the *present* appearances of the vale can fairly be employed to support opinions as to its condition before the flood. The vale of Pickering has a partial surface of alluvial sediment, and a general covering of diluvial clay and pebbles, upon a substratum of blue clay. How vast a load of diluvium lies on this stratum, in particular situations, is known to those who have inspected the cliffs between Speeton and Filey; and similar accumulations prevent it from appearing in all the central part of the vale. The present flat appearance of this great hollow, therefore, is owing to the effects of the deluge and subsequent causes; and affords no clue to its antediluvian condition."

"*The Chalk Wolds.*

"The wolds of Yorkshire form one of the most remarkable features in this county. High and bare of trees, yet not dreary nor sterile, they are furrowed as all other chalk-hills, by smooth, winding, ramified valleys, without any channel for a stream. Where several of these valleys meet, they produce a very pleasing combination of salient and retiring slopes, which resemble, on a grand scale, the petty concavities and projections in the actual channel of a river. No doubt these valleys were excavated by water, but not by the water of rains, or springs, or rivulets. Some greater flood, in more ancient times, has

performed

performed the work, and left the traces of its extent in the pebbles which it has deposited along its course."

"In wells and pits sunk on the wolds, the chalk has been several times perforated, and found to rest on Kimmeridge clay, near Sherburn, and on lias, containing characteristic fossils, (of which specimens have been presented to the Yorkshire Philosophical Society by the Rev. T. Rankin,) at Huggate. The latter fact is highly important, as it shows to what an extent the unconformed arrangement prevails under the central part of the wolds.

"*Holderness.*

"Holderness, taken as a natural division, may be said to include the whole country lying between the eastern slope of the Yorkshire wolds, the German Ocean, and the channel of the Humber. Its western limit passes by Bridlington, Burton-Agnes, Driffield, Beswick, Beverley, and Cottingham, to Hessle; what may have been anciently its extent towards the east and south-east, is not easily determined, because on these sides it is exposed to a turbulent sea, which its loose materials are ill calculated to resist. Its greatest length is somewhat less than forty miles, and its extreme breadth about sixteen. It includes about three hundred and eighty square miles of surface, of which, perhaps, seventy square miles are marsh-land, relinquished by the sea, according to a regular process of nature, or reclaimed by the enterprising industry of man. The remainder of the surface, though, on a general view from the wold-hills above, it appears like one extended plain, is found, on closer inspection, to be remarkably undulated; and though no land in the whole district exceeds one hundred and forty feet in height, yet as the valleys are often sunk to the level of the sea, the hills assume a degree of importance which a stranger would by no means expect."

"There is, perhaps, hardly any district in the island, which displays in so striking a light the powerful effects of the deluge as Holderness; for in this country its accumulations compose the whole mass of every hill, and form the deep foundation of every marsh. In the cliffs of the coast and in the gravel-pits of the interior, remains of antediluvian animals are frequently met with, and the interest which these discoveries cannot fail to excite, is increased by the abundance of the alluvial deposits which have happened in the same country at various subsequent periods, and contain the bones of animals of a more recent date. The remains of creatures overwhelmed by the flood, and of those which perished after it, lie here not far asunder; the circumstances attending their destruction may be deliberately examined, and the contemplative mind is presented with a physical record of the principal changes to which the surface of the earth has been exposed from the deluge to the present day.

"The lowest of all the accumulations which rest upon the chalk of the wolds is an irregular layer of fragments of chalk and flint, which, being derived from the stratum beneath, are very little water-worn. This singular deposit seems due to a less violent action of running water than the general mass of heterogeneous pebbles which covers it.

it. It seems to indicate that the effects of the deluge were produced at different periods; as if the water had been liable to great periodical ebbing and flowing. I am not aware that any remains of land animals have occurred in this rubbly deposit, near Flamborough, or on the wolds; but at Hessle it contains the teeth, and bones of the extremities, of horse, ox, and deer, very little worn by attrition. These bones, therefore, belonged to animals residing in the neighbourhood; and as they are now covered up by a great thickness of clay and pebbles, derived from a far greater distance, we cannot doubt their antediluvian origin. I think the rubbly layer of chalk and flint fragments is not found on the highest parts of the wold-hills, but has been drifted chiefly to the lower part of their slopes."

"The thickest and most extensive of the diluvial accumulations in Holderness is a mass of clay and pebbles. In the cliffs north of Bridlington and at Hessle, it is seen to cover immediately the water-moved rubbly chalk and flint, which lie on the great stratum of chalk. It extends in a connected mass, under nearly all Holderness, forming most of the hills and 'hard land,' and underlying most of the accumulations of gravel and alluvial sediment. In the highest cliffs on this coast, its thickness is not less than one hundred and thirty feet. Its composition is remarkably uniform. We every where observe it to be a solid body of clay, containing fragments of many pre-existent rocks, which vary in magnitude, and in the degree of roundness to which they have been reduced. The fragments are, in general, not so numerous as to touch each other, but are scattered through the clay as plums in a pudding. However, on the top, or in the uppermost part of the deposit, they are sometimes aggregated into distinct layers of gravel, which continue for a short distance, and furnish springs of good water. The rocks from which the fragments appear to have been transported are found, some in Norway, in the highlands of Scotland, and in the mountains of Cumberland; others in the north-western and western parts of Yorkshire, and no inconsiderable portion appears to have come from the sea-coast of Durham, and the neighbourhood of Whitby. In proportion to the distance which they have travelled, is the degree of roundness which they have acquired. All the fragments of granite, porphyry, mica slate, and clay slate, which can be compared with no fixed rocks nearer than those of Cumberland and Westmoreland, are rolled to pebbles; the angles are worn away from every mass of limestone which has been drifted from the north-western hills of Yorkshire; but those which have been brought from the nearer points of the chalk range have yielded much less to attrition. Some attention is required to the original hardness of the stones: we find solid masses of ironstone and quartz much less worn than granite; limestone less rounded than millstone grit; and flint with uninjured angles, whilst chalk and magnesian limestone have lost their original surfaces."

The following notices respecting the supposed crag of Holderness are found, pp. 53, 54.

"Amidst this heterogeneous mass, which indicates such various and violent currents of water, it is remarkable that we find many rather

rather delicate marine shells, in tolerable perfection. Besides the strong shells of Turbo littoreus, Purpura lapillus, and Buccinum undatum, we have Mya arenaria, Tellina solidula and tenuis, Mactra subtruncata? Cardium edule*, and a shell which appears to me to be Crassina scotica. The shells are most abundant along particular layers in the gravel. The mass descends to a great depth, and is found beneath the adjacent marsh-land, which consists of fine clay, lying upon peat and trees, and is part of an extended level tract, reaching from the Humber near Pattrington, almost to the sea, at Sandley mere. It seems to have been, at some former period, a channel for some vast volume of water; for it winds as other valleys do, and the gravel hills which bound it are abrupt on the concave side, and slope gently down on the other."

The alluvial deposits in Holderness are extensive and interesting:—

"The lakes, which were left on the retiring of the diluvial currents, appear to have been continually diminished in depth, and contracted in extent, by deposits of vegetable matter, decayed shells, and sediment, brought into them by land-floods. In this manner a surprising number of inland lakes have been extinguished in Holderness, and nothing remains to denote their former existence, but the deposits by which they have been filled."

"All the lacustrine deposits containing peat, which I have inspected in Holderness, agree in this general fact, that the peat does not rest immediately upon the diluvial formation beneath, but is separated from it by at least one layer of sediment, which is seldom without shells. The peat is very generally confined to a single layer, and shells are seldom found above it. Supposing that all the varieties which I have witnessed in different places existed together, the section would be nearly in the following general terms:—

"1. Clay, generally of a blue colour, and fine texture.
2. Peat, with various roots, and plants, and in large deposits containing abundance of trees, nuts, horns of deer, bones of oxen, &c.
3. Clay, of different colours, with fresh-water lymnææ.
4. Peat, as above.
5. Clay, with fresh-water cyclades, &c. and blue phosphate of iron.
6. Shaly curled bituminous clay.
7. Sandy coarse laminated clay, filling hollows in the diluvial formation.

"Of these, the most constant beds appear to be No. 1, 2, and 5, and, in general, these constitute the whole deposit. In different places, the layers exhibit much diversity of colour, consistence, and thickness. The peat varies in its thickness from five feet to less than as many inches, and its constituent parts seem not the same: in a few instances there are no shells in the lower clay, and when they do occur,

* "It must be owned the gravel shells are generally less truncate posteriorly, and less convex than the recent specimens; but there are variations in the form of Cardium edule, some individuals being more oblique than others: both varieties occur in this gravel-pit."

occur, they are sometimes of different kinds; cyclades and paludinæ are most plentiful. Anodons occur in it at Owthorne, but I did not find them elsewhere.

"The quadrupedal remains which have been found in this lacustrine formation, belong principally to deer. Bones of oxen likewise occur in it. Of deer, at least, three species have been discovered in the peat and clay; the great Irish elk (C. giganteus), the red deer (C. elaphus), and the fallow deer (C. dama). A doubtful skull, (found at Owthorne,) in the possession of the Yorkshire Philosophical Society, has some resemblance to the cranium of the chamois goat."

(To be continued.)

LVII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Feb. 3.—A PAPER was read, entitled, "On the Lunar Theory." Communicated by the Rev. Dr. Lardner.

The subject treated of in this paper is introduced by a review of the labours of Clairault, Euler, D'Alembert, and Thomas Simpson. The theories of these eminent men, the author remarks, were very deficient in accuracy, and were not at all adequate, without correction from observation, to the construction of tables. They could serve only to point out the arguments of the equations, and not all even of these. The inequalities of the moon's motion are investigated by approximating processes, which lead to results more or less accurate, according as the approximations are carried to a greater or less extent. The writers above mentioned had contented themselves with short and easy approximations; and though they had accomplished much, had yet left much more to be done. Subsequently to these, Mayer published an elaborate theory of the moon; but his coefficients required much correction, the results of his computations being in some cases found to differ very widely from observation. A much greater degree of accuracy was attained by Laplace, who bestowed particular attention on the influence of minute quantities in every part of his theory. In the present paper the author has endeavoured to introduce further improvements in the lunar theory, by carrying the approximations considerably further than has hitherto been done.

In the solutions of the problem given by former mathematicians, the chief obstacle to the attainment of accuracy was the extreme length and labour of the necessary computations. Another object, therefore, which the author has had in view, is to facilitate these computations, and render them less laborious. This he endeavours to effect by the employment of certain artifices, by which the multiplicity of small terms will, with their co-efficients, be reduced within a practicable compass, and their numerical computation rendered less appalling.

The

The co-efficient of the equation depending on the moon's distance from the sun, affords the means of calculating the sun's horizontal parallax. For this purpose Laplace has computed this co-efficient with greater accuracy than the rest; and he makes the sun's parallax nearly $9''$. The author's theory gives it little more than $8''\frac{1}{2}$, which is very near the mean of the various results obtained by the observation of transits. He thinks that there is, therefore, great reason to conclude that its true value is about this quantity.

Feb. 10.—The reading of a Paper, entitled, "On a New Combination of Chlorine and Nitrous Gas." By Edmund Davy, Esq. F.R.S. M.R.I.A. Professor of Chemistry to the Royal Dublin Society. Communicated in a Letter to Davies Gilbert, Esq. late President of the Royal Society;—was commenced.

Feb. 17.—The reading of Professor Davy's Paper was resumed and concluded.

In the course of his experiments on a new test for chlorine gas, an account of which was lately read to the Royal Society, the author was induced to examine the gases produced by the mutual action of nitric acid and different chlorides, and also of the nitric and muriatic acids on each other. When fused chloride of sodium, potassium or calcium, in powder, is treated with as much strong nitric acid as is sufficient to wet it, a considerable action takes place: cold is produced, and a gas of a bright reddish or yellowish colour is copiously evolved, which evolution is promoted by applying a gentle heat. This gas, especially in the early stage of the process, appears to be a mixture of chlorine and another gas, distinguished from it by the great facility with which it is absorbed by water. From this circumstance, and from its also exerting a considerable action upon mercury, its properties cannot be satisfactorily ascertained by collecting it in contact with either of these fluids; but as it is much heavier than common air, the author was enabled to collect it in sufficient quantity for examination, and nearly in a pure state, from a tubulated retort by means of a bent tube reaching to the bottom of small narrow-mouthed bottles, with ground stoppers.

The gas, when thus obtained, is of a pale reddish yellow colour; has an odour somewhat resembling that of chlorine, though less pungent. From its strong affinity for moisture, it fumes when brought into contact with the air. In its ordinary state of dryness it destroys vegetable colours, readily bleaching turmeric paper: litmus paper, however, is reddened by it before it is bleached. But when carefully dried by means of fused chloride of sodium, it does not affect those substances. This gas does not support combustion; but the bifulminate of silver explodes in it.

The author next describes its action upon phosphorus, sulphur, antimony, arsenic, bismuth, tin, copper, zinc, iron, lead, gold, silver, platina, mercury, sulphuric ether, alcohol, oil of turpentine, naphtha, concentrated muriatic acid, iodine, and bromine. With hydrogen gas it forms a mixture which explodes when ignited.

The general conclusion which the author draws from his experiments, is that this gas is an actual compound of chlorine and nitrous

 gas,

gas, and he therefore gives it the name of the chloro-nitrous gas. When collected over mercury, one portion of it forms with that metal a white compound, which appears to be a mixture of calomel and corrosive sublimate, whilst the remainder is found to give orange vapours with common air, attended with a diminution of volume, and to be almost wholly absorbed by a recent solution of green sulphate of iron. He also infers that the gas consists of equal volumes of chlorine and nitrous gas, combined together without any condensation, its atomic number being 102. He finds its specific gravity, compared with that of atmospheric air, to be 1.759.

In the mutual decomposition of chloride of sodium and nitric acid, the products appear to be chloro-nitrous and chlorine gases, and nitrate of soda. The author explains the changes which take place in the following manner:—the nitric acid, by its partial decomposition, yields nitrous gas and oxygen: the former unites with part of the chlorine expelled from the chloride of sodium, to form chloro-nitrous gas, whilst the latter combines with the sodium to form soda, which, with the remaining nitric acid, compose nitrate of soda. The remainder of the chlorine mixes with the chloro-nitrous gas.

The author states that the two component gases of the chloro-nitrous gas unite at once when brought into contact, after having been dried in the most careful manner possible; a fact which is contrary to the opinion generally entertained among chemists.

By passing chloro-nitrous gas through water an acid is obtained, which appears to resemble very closely the common solvent of gold, or *aqua regia*, otherwise called the nitro-muriatic acid. The author here remarks, that if the constitution of the chloro-nitrous gas be such as he has stated, that is, composed of 30 by weight of nitrous gas and 72 of chlorine, one of its proportionals should decompose two of water, consisting of 16 oxygen and 2 hydrogen; thus forming 46 nitrous acid, and 74 muriatic acid. But an acid so constituted should be incapable of acting on gold or platina; now the acid resulting from the absorption of chloro-nitrous gas by water has this power.

The author concludes from his experiments, that the power of nitro-muriatic acid in dissolving gold is not owing to the liberation of chlorine, and that muriatic acid may be separated from nitric acid, even when the latter is only half the volume of the former. He regards chlorine and chloro-nitrous gases as the gaseous products arising from the mutual action of strong nitric and muriatic acids on each other. The nitro-muriatic and chloro-nitrous acids strongly resemble each other in their action on platina, though the solvent power of the latter is decidedly greater than that of the former; and the addition of water considerably increases this power in both, probably by counteracting their disposition to assume the elastic state. Both acids form, with different bases, salts which are mixtures of nitrates and chlorides. The principal differences in these acids may arise from their mode of preparation, and is probably due to the want of uniformity in their composition.

Feb 24.—A Paper was read, entitled, "On the Chemical Action of

of Atmospheric Electricity." By Alexander Barry, Esq. F.L.S. Communicated by J. G. Children, Esq. Sec. R. S.

A kite was raised in an atmosphere which appeared favourable to the exhibition of electrical phenomena, from an apparatus firmly fixed in the earth, and insulated by a glass pillar. The string to which it was affixed contained a double gilt thread, and was let out to a length of five hundred yards. It was connected with a platina tube passing about half way down a glass tube full of a solution of sulphate of soda, coloured with syrup of violets, and inverted in a cup containing the same liquid. A similar wire in another tube, also filled with the coloured solution, was placed in communication with the earth, and the fluids in each made to communicate by a bent glass tube passing from one cup to the other. The result of the experiment was, that hydrogen gas and alkali were developed in the first tube, and oxygen gas and acid in the latter.

The reading of a Paper, entitled, "An Account of Operations carried on for ascertaining the Difference of Level between the River Thames at London Bridge and the Sea: and also for determining the Height above the Level of the Sea, &c. of intermediate points passed over between Sheerness and London Bridge." By John Augustus Lloyd, Esq. F.R.S.;—was commenced.

Mar. 3.—The reading of Mr. Lloyd's Paper was resumed and concluded.

The author of this paper received directions from the Lords Commissioners of the Admiralty, in February 1830, at the suggestion of the Royal Society, to survey the river Thames, with a view of ascertaining the difference of level between certain parts of it and the mean level of the sea near Sheerness. Having had experience, while employed in a survey of the Isthmus of Darien, of the great imperfections in the levelling instruments hitherto used, he bestowed great pains in improving the construction of those employed in the present survey; endeavouring to combine the properties of great steadiness and accuracy of motions in azimuth, with increased delicacy in the level, and permanence in the general position of the whole apparatus; and also to increase the power of the telescope. The author then enters into a full description of the improved instruments which he employed, accompanied by drawings.

As soon as he was furnished with the proper means of observing, he commenced his operations at Sheerness in the month of March. The principal object of his commission being to ascertain the heights of different places above the level of the sea, it became necessary, in the first place, to estimate the heights of the tide; and accordingly having obtained permission from the Admiralty to erect a tide guage at the Dock Yard at Sheerness, he selected a corner of the boat basin as the most eligible spot for this purpose: having accomplished this object, he next directed his attention to the establishment of a standard mark, from whence, as from a zero point, the levellings might be reckoned. Considerable difficulty was met with in fixing upon a spot in every respect adapted to this object; for all the buildings in the immediate vicinity of the tide gauge appeared

to

to be deficient in the security of their foundation. He at length selected a large block of granite in the southern pier of the entrance to the boat basin. He then caused a block of gun metal, cast for the purpose, two inches and a half square and eight inches long, to be sunk in the centre of the granite, about an inch below the surface, thereby allowing a brass box and cover to be placed over the standard to protect it from injury. In order that there might be a sufficient number of checks to the permanence of this standard mark, the author caused others to be placed in the yard; namely, one near the southern extremity on the wall of the Dock Yard, one at the eastern side of the great basin, and one in a large block of stone resting on the brick-work of the navy wall. As a further means of future verification of this standard level, he had a very large block of granite placed on a slight eminence, two miles and a half to the southward of the Dock Yard, on which there formerly stood the old castle of Queenborough. One of the brass standards being let into the granite, the place was covered over, but marked by a small mound of earth near it, so that it may easily be referred to whenever it may be thought requisite.

From a series of observations made at Sheerness in the years 1827, 1828, and 1829, it is found that the mean high-water spring tides was 26·355 feet, low-water spring tides 8·74; mean 17·649. The mean high-water neap tides 22·656, low-water 11·336; mean 16·993. The mean of the whole period being 17·27.

The author then states the results of the successive levellings he took from Sheerness along the course of the river to London Bridge. On his arrival at Greenwich Hospital, he commenced a set of branch levels from thence to the Royal Observatory, for the purpose of determining its height above the level of the sea,—an operation which was rendered tedious by the abruptness of the ascent. Having completed these observations, it occurred to the Astronomer Royal that the instruments employed in the survey might be used as a means of verifying the correctness of the horizontal point of the mural circles. The coincidence of the horizontal wires of the two instruments was found to be so nearly perfect, as to agree within a few hundredths of a second. From Greenwich the levelling was continued on the opposite side of the river to different places where tide-registers had been kept. By the kindness of Mr. Lubbock, the author was furnished with the results of twenty-six years' observations on the tides at the London Docks; from which it appears, that the height of mean high-water mark there, above that at Sheerness, is 2·24 feet, and the height of spring tide high-water mark 2·03, and of neap tides 2·35. The Trinity mark on the western side of Old London Bridge is 2·16 feet below the north standard mark at Sheerness, and 1·9 foot above the mean spring tide high-water mark at Sheerness.

The author concludes by giving a long catalogue of standard marks and other points of reference between Sheerness and London Bridge, the north standard at Sheerness being taken as the zero point.

In the course of his observations he found reason to believe that the tremulous appearance of the air which has been termed *mirage*, is

is caused, not so much by evaporation as by the direct effect of the solar rays: for he remarked, that when there was a succession of clouds passing over the sun, the tremor was very great at those times when the sun shone; but the moment the sun was obscured over the whole space between the instrument and the object viewed, the air was perfectly tranquil.

Mar. 10.—It being stated to the Meeting by the President that Mr. Caldcleugh, elected that evening, was on the point of leaving England for Mexico, and would consequently have no other opportunity during this session of attending for admission, Mr. Caldcleugh was allowed to sign the Obligation in the Charter Book, and was admitted a Fellow of the Society.

A Paper was read, entitled, "Description of a Graphical Register of Tides and Winds." By Henry R. Palmer, Esq., Civil Engineer. Communicated by J. W. Lubbock, Esq. V.P. & Treas. R.S.

The author having long directed his attention to the effects likely to be produced on the tides in the river Thames, in the port of London, by the removal of London Bridge, was desirous of obtaining a series of accurate observations during all the changes of the tides; and for this purpose constructed a machine, which, being acted upon jointly by a time-piece and by a float resting on the water, registered of itself, upon a piece of paper, both the height of the tide, and the direction of the wind.

A number of parallel and equidistant lines, representing feet in height, are engraved, and printed on long sheets of paper, the ends of which are joined together until a sufficient length is obtained for the purpose required. This long sheet is wound upon a brass roller, which is placed near the lower part of a cylinder one foot in diameter, so that the paper may pass round it; its contact being preserved by a roller above, pressing upon it by its own weight. On the axis of the cylinder is a toothed wheel, which is acted upon by a clock, producing an equable motion in the cylinder, which is thus made to complete one revolution in six hours. By means of another wheel, at the expiration of every hour a hammer is raised, whose fall strikes on an upright punch connected with a weather-cock on the top of the building; and the figure of an arrow being cut on the lower end of this punch, an impression of the arrow is made upon the paper: as the direction of the arrow always corresponds with that of the wind, the direction of the latter is thus hourly registered.

Immediately over the axis of the cylinder, and parallel with it, is a rack carrying a pencil. The rack is acted upon by a pinion, which receives its motion from the float on the water: so that as the tide rises or falls, the pencil is moved backwards and forwards through a space which bears a determinate ratio to the actual rise or fall of the float: and thus, by the combined motions of the cylinder and of the pencil, the one regulated by the clock and the other by the tide, a line is traced on the paper, giving a representation of both.

The float, which rests on the water, is a hollow plate-iron vessel, suspended by a chain, which passes twice round a light cast-iron barrel,

barrel, and then descends, having a counter-weight attached to it. The float is placed in a well communicating with the river, through a fine wire gauze, which prevents the undulations of the surface from affecting the water in the well.

The author concludes by an account of an application of similar machinery to the determination of the precise times of high water, and the construction of accurate tide-tables. He proposes, with this view, an instrument which shall record the height of the tide at every minute, and promises to give to the Society a full description of such a machine when it shall have been completed.

Mar. 17.—A Paper was read, entitled, "Proposed Plan for supplying filtered Water to the Metropolis and its Suburbs." By Lemuel Wellman Wright, Esq., Civil Engineer. Communicated by T. J. Pettigrew, Esq. F.R.S.

The author, after giving extracts from the Report of the Commissioners appointed by His late Majesty to inquire into the supply of water to the metropolis, in support of the practicability of affording a supply of filtered water from the Thames, adequate to the demand, and within reasonable limits in point of expense, proposes his plan of forming a filter under the bed of the river, for each Company. He states that the deposit of mud on each side of the Thames does not reach below the low-water mark, and that the bed of the river throughout is generally a clean and strong, though porous gravel. The mud, therefore, will puddle in, and close the pores of the bed of gravel on which it lies, above low-water mark, so that the filtration into the neighbouring wells, the waters of which are remarkably pure, must take place below low-water mark. He therefore proposes to construct a filtering chamber below the bed of the river, from which chamber a main pipe or tunnel must be made for conducting the filtered water into a well on the river side, whence it is to be drawn up by steam power, and distributed to the houses to be supplied, by the mains and branches at present existing.

The filtering chamber and apparatus are to be prepared by erecting a coffer-dam in the river, of sufficient size to inclose the whole of the area required for that purpose. This coffer-dam will require piles of forty-five feet in length. The bed of the river, thus laid dry, is to be dug out, and a bed of brick-work, set in cement, laid down: a floor must then be constructed in the form of an inverted segment of an arch. On the top of the walls of this floor, plates are to be laid, and in the inclosed area, granite blocks placed; upon these again, the girders are to be laid, and over these the joists, which are to support a first layer of large flints. Upon these, successive layers of smaller flints are to be laid, each decreasing in size as they approach the bed of the river. Upon the uppermost of these, a stratum of clean shingle is to be deposited; then a bed of fine and very clean gravel; and lastly a bed of filtering sand, until it arrives within a foot of the bed of the river, which last space must then be filled up with clean gravel; thereby forming a filtering bed of eight feet in depth, the top of which will still be four feet below low-

low-water mark. So that, allowing seven feet for the timbers and brick-work below, and eighteen feet for the rise and fall of the tide, the total depth at high-water will be thirty-seven feet.

The paper is accompanied by a lithographic drawing, which exhibits the several parts of the scheme.

A Paper was read, entitled, "On the Variable Intensity of Terrestrial Magnetism, and the Influence of the Aurora Borealis upon it." By Robert Were Fox. Communicated by Davies Gilbert, Esq. V.P.R.S.

The author gives the results of a series of observations on the vibrations of the magnetic needle, which he undertook last summer, for the purpose of ascertaining whether the intensity of its directive force is affected by the changes in the earth's distance from the sun, or by its declination with respect to the plane of its equator. He observed that the magnetic intensity is subject to frequent variations, which are sometimes sudden, and of short duration. These anomalies he has been unable to refer to any obvious cause, except when they were accompanied by the appearance of the aurora borealis, which evidently affected the needle on many occasions. He also thinks that the vibrations of the needle became less rapid with a moist atmosphere, and more so when it was very dry. Changes of the wind and snow storms appeared also to be attended with fluctuations in the intensity of the magnetism. He endeavoured to ascertain whether there existed any decided and constant difference in the directive force of each pole; conceiving that, on the hypothesis of a central magnetic force, the north pole of the magnet would, in these northern latitudes, be acted upon with much greater energy than the south pole. From his observing that the relative intensity of the two poles is not always the same, he infers the probability of the earth's magnetism being derived from the agency of electric currents existing under its surface as well as above it, and that the rapid fluctuations in its intensity are owing to meteorological changes.

The author is led to conclude that the aurora borealis is an electrical phænomenon, and that it usually moves during the night nearly from north to south, and in an opposite direction during the day; that it is of the nature of positive electricity; and that its elevation above the earth is much greater than a thousand, and perhaps thousands of miles.

ASTRONOMICAL SOCIETY.

Jan. 14.—The following communications were read:

I. On the computation of observed Occultations, by Mr. Maclear.

II. Observations of the right ascension of Venus, to determine the mass of the Moon (as recommended by Professor Airy), by Professor Nicolai at Mannheim, and Professor Schwerd at Spire.

Along with the observations of Venus, Professor Nicolai has sent his observations of Gambart's comet.

III. Observations of the right ascension of Venus, about her inferior conjunction, by Professor Santini, at the Imperial and Royal Observatory of Padua.

Along with the observations of Venus, Professor Santini has transmitted

mitted positions of Gambart's comet, deduced from observations with the equatorial instrument of the Observatory of Padua, by himself and his colleague, Dr. Conti.

IV. A letter from Professor Bianchi, of Modena, containing observations of the right ascension of Venus.

V. Occultations of the Stars and Planets observed at Dorpat, by Professor Struve.

Professor Struve observes, that "even with such a powerful telescope as the Dorpat refractor, it is not easy to observe the *emersion* of faint stars from the moon's bright limb. But the micrometer, with the clock-work horary motion, affords a very satisfactory method of measuring the distance of a star, after emersion from the enlightened disc. These observations replace a lost emersion, and have even this advantage over an emersion exactly observed—that they do not depend upon the inequalities of the edge of the moon. Such micrometrical measures, both at immersion and emersion, will be found in the accompanying occultations of the Hyades. An accurate computation will show what degree of accuracy may be expected from this mode of observing, and if there be a constant error in the apparent diameter of the moon depending upon the telescope employed. These measurements are, however, very difficult, and, I should think, better adapted to Fraunhofer's heliometer than to the wire micrometer."

The telescopes were variously adjusted, upon close double stars, upon Aldebaran, and upon the moon; but though there were four or more observers, in no instance was any projection seen. The disappearances took place instantaneously, when the apparent centre of the star entered upon the edge of the moon, and the re-appearances were also instantaneous; neither was there any previous variation in the brilliance of the star.

The observations consist of

An occultation of Saturn by the moon...	16 Feb. 1826	
An occultation of α Tauri..................	25 July 1829	Four observers.
————————	15 Oct. ——	————
Occultations of α Tauri and the Hyades	9 Dec. ——	Six observers.
Occultations of the Hyades	28 Mar. 1830	

VI. Two notes by Mr. Lubbock, on the comet of Halley.

In the first of these notes Mr. Lubbock has deduced the elements of the orbit of this comet from Messier's observations, adopting the value of the semiaxis major given by M. de Pontécoulant, and the perturbations due to the principal planets computed by M. Damoiseau. The elements thus obtained satisfy, with considerable exactness, Messier's observations from Jan. 22 to June 3, as is seen from an accompanying table: and as they differ sensibly from those stated by the author in his paper, vol. iv. p. 42, he wishes them to be substituted in that place.

Semiaxis major......................	18·0763	
Excentricity	·9676	
Perihelion passage 1759, March	13·333	Mean time from Paris midnight.
Inclination of orbit	17° 36′ 0″	
Longitude of the ascending node	53 45 0	Referred to the mean equinox 1759.
Longitude of perihelion	303 3 20	

Adding

Adding to the above elements the perturbations given by M. de Pontécoulant, the elements for 1835 are as follow :

Semiaxis major	17·98355
Excentricity	·967348
Perihelion passage, 1835, Oct. 31	$4^h\ 47^m$ Mean time from Paris midnight.
Inclination	17° 42′ 50″
Longitude of ascending node	55 3 59
Longitude of perihelion	304 23 39

Mr. Lubbock then briefly explains the mode by which these elements were computed.

In the second note, Mr. Lubbock analyses a very valuable paper upon the same subject, by M. Rosenberger, contained in the *Astron. Nach.* Nos. 180 and 181.

M. Rosenberger first obtained approximate elements from five of Messier's observations, adopting the semiaxis major of Damoiseau. He then calculated the effect produced upon the elements by the perturbations of the seven large planets, for every ten days, from the 1st of January to the end of May 1759. With the corrected elements belonging to each day, he computed an ephemeris of the comet, employing, for this purpose, the Solar Tables of Carlini, as corrected by Bessel, having regard both to precession and nutation. These computed places were carefully compared with the observed places. The positions of the stars with which the comet was compared were taken, when possible, from the *Fundamenta Astronomiæ*, or Piazzi's Catalogue. When these were wanting, the *Histoire Céleste* and Bessel's *Zones* were resorted to, and many stars were determined by Professor Bessel for this purpose. In reducing the observations, parallax and the differences of refraction were taken into account. Finally, all the observations which could be depended upon, those of Messier, Maraldi, Cassini, Bradley, Hell, and Darquier, were combined and made use of by the method of least squares. The elements resulting from this comparison are compared with Messier's observations, and the differences do not exceed half a minute in space. Mr. Lubbock finds the differences between his elements and those of M. Rosenberger more considerable than he had expected, especially the excentricity: they are, however, of the order of the uncertainty which must exist in the calculation of the perturbations of the elements, between 1759 and 1835, and therefore practically of little importance.

It is to be regretted that M. Rosenberger has not used the semiaxis major of M. de Pontécoulant. He has, however, computed the variation of the elements produced by a small change in the semiaxis major, whence, adopting the value given by M. de Pontécoulant, the elements of the orbit are

Semiaxis major	18·0763
Excentricity	·96766333
Perihelion passage 1759, March	13·0763 Mean time from Paris midnight.
Longitude of ascending node	53° 47′ 47″·19
Distance of perihelion from node	110 37 27 ·90
Inclination of orbit	17 21 44

Mr. Lubbock is, however, inclined to doubt whether this method

is applicable, except when the change in the semiaxis major is very minute.

"This comet is one of those which most nearly approach the orbit of the earth. When in one of its nodes, it may be at a distance from us equal to $\frac{1}{20}$th of our distance from the sun; but the mass is so small, that a much nearer approach would give no just cause for alarm.

"It is to be hoped that ephemerides of this comet will be given for 1835, calculated upon at least three different hypotheses, with respect to its perihelion passage, in order that astronomers may know the lines in which to sweep for it each day, so that it may be detected as early as possible."

VII. A Letter from Mr. Herapath to the President, announcing the discovery of a comet*.

LINNÆAN SOCIETY.

March 1.—Read, a letter from James Lindsay, M.D. describing the *Helix obvoluta,* found in Hampshire, addressed to R. I. Murchison, Esq. Pres. G.S.

The author last May met with this, along with other *Helices,* such as *nitida* and *rufescens,* amongst the moss and roots of trees in Dibham wood near Brinton, Hampshire, and along the north side of the South Downs. There are smooth tooth-like processes on the inner side of the lip, of which Lamarck takes no notice. The aperture is triangular, mouth a little reflected, forming a distinct sinus externally, and altogether answering to the Lamarckian description.

Read also, A communication on the Recent Nautilaceous Mollusca of Great Britain, by J. G. Jeffreys, Esq. F.L.S.

March 15.—Read, continuation of Mr. Jeffreys's paper.

April 5.— A paper was read, entitled, "On the Osteological Symmetry of the Camel; *Camelus Bactrianus* of Aristotle, Linnæus, and Cuvier. By Walter Adam, Fellow of the College of Physicians of Edinburgh." Communicated by Robert Brown, Esq. V.P.L.S.

The objects of this elaborate paper are, to state minutely the dimensions of the several bones of a large quadruped, the Camel having been selected to illustrate the general type of its class, on account of its size; to trace the mutual relations of these dimensions; and thus to exemplify the general osteological form in animals of similar configuration. The bones are described in accordance with the nomenclature of Dr. Barclay. After a brief exordium stating the objects of the paper, as just described, and an explanation of some of the terms employed, the author proceeds to detail the proportionate dimensions of the bones constituting the entire skeleton of the Bactrian Camel, in the following order; viz. the head; the vertebræ, classified in the usual manner; the sacrum; the tail; the ribs; the cavity of the thorax, and the sternum; the scapula; the pelvis, and the limbs. The height, the breadth, and the basilar length of the cranium, Dr. Adam states, are very nearly in the proportion

* See our present volume, p. 154.

1, 2, 4. The common difference in the palatal, the coronal, the basilar, and the extreme length of the cranium, is the breadth of the cranium at the temporal fossæ: these lengths, in the animal examined, being, respectively, 12, 15, 18, 21 inches. The lateral extent of the atlas is equal to the distance between the inner margins of the orbits. The greatest elevation of the spine is at the third dorsal vertebra; the extreme length of that bone equalling the greatest extent of the pelvis towards the mesial plane. The longest of the twelve ribs are the seventh and the eighth; their length equals the greatest extent of the scapula. The sum of the lengths of the twelve ribs is about ten times that of the longest rib. The dimensions of the cavity of the chest agree with those of the separate bones of the body; thus, the greatest width of the chest is equal to the greatest length of the head. The breadths of the pelvis, *rostrad*, (measured towards the front), from the acetabula, are even numbers of proportional parts. The breadths, *caudad*, (measured towards the tail), from the acetabula, including the acetabular breadth itself, are odd numbers of proportional parts. The chief dimensions of the pelvis are identical with the chief dimensions of the head; thus, for example, the greatest dimension of the pelvis, being through the mesial plane, is equal to the greatest length of the head. The lengths of the four long bones of the atlantal (fore) limbs, independent of processes and elevations, are consecutively as the numbers 22, 28, 20, 6,—sum 76. The similar lengths of the four long bones of the sacral (hind) limbs are consecutively as the numbers 28, 23, 20, 5,—sum 76. The author observes, in conclusion, that, from the exposition given in the paper it appears that throughout the dimensions of the bones of the Bactrian Camel there is such an agreement, that many of the dimensions are continued proportionals, and that the mutual relations of nearly all admit of a very simple expression; and he states that corresponding relations have been found to prevail in the bones of every species of animal he has examined. From the full verification of these observations in the osteology of other animals, it will result, he infers, that zoology is susceptible of a classification established on the fixed basis of number, that the tissues by which the bones are moulded are also of determinable proportions, and that, consequently, the development of the parts of organized bodies, &c. &c. afford a wide scope for numerical as well as for physiological inquiry.

The various proportions are minutely exhibited in twenty-eight folio tables; the first column of each giving the actual dimensions of an individual camel, and those measurements being in the next column adjusted to the normal proportion, on the assumption, that the aberrations in the form of an individual animal, from the perfect form of its species, may be at least as great as the inequalities of the right and left sides of that individual itself. The numbers assigned to the normal proportions, however, are regarded merely as approximations.

April 19.—Read, continuation of Mr. Jeffreys's paper.

ZOOLO-

ZOOLOGICAL SOCIETY.

February 22, 1831. N. A. Vigors, Esq. in the Chair.

A specimen was exhibited of a young *Nyl-ghau,* (*Antilope picta,* Pall.,) which was born at the Society's Farm in January last. The mother of this individual had borne two young about twelve months since, while in the possession of His late Majesty. On the present occasion she had also borne two, one of which is still living. The differences between the young and the adult animal were pointed out. The latter is well known. The former is generally of a dull reddish fawn colour, which is brighter on the lower part of the legs. A line along the belly, descending a short distance down the inside of the legs, together with a line on the fore part of the hock, is white. The under lip, a line along its under surface, and a crescent-shaped spot mounting on each side round the base of the lower jaw, are also white. A spot above the front of the eye, and one behind the angle of the mouth are white, as are also the inside of the ears. A black line passes along the middle of the nose, and spreading out between the eyes, becomes suffused and lost. From between the ears a black line passes along the middle of the back to the root of the tail. A black line passes down the front of the fore legs, commencing near their upper part, expanding in front of the knees, then contracting, and afterwards dilating again above the base of the hoof, which it surrounds. Above the pastern on the inner side is a white spot; and there is a white spot just above the hoofs both on the outer and inner side. On the front of the lower part of the hinder legs there is a black line, and the pastern and feet are black. Above the pastern the limb is surrounded in front by a broad half ring of white; and there are two white spots, nearly uniting in front, above the hoofs. The ears at their base for more than half their length, together with their extreme tip, are of the general fawn of the body becoming much lighter towards their outer margin: but a broad black blotch occupies nearly their upper half, with the exception of the extreme tip. The tail is white beneath, and its tip is black.

Mr. Cox adverted to the prevalence among *Sheep* of *prolapsus uteri,* which he stated to be almost universally fatal to the animals afflicted with it, and for the relief of which he pointed out a simple and efficient method. In a sheep suffering from this cause he removed the protruded parts by the application of a ligature; the animal was subsequently turned out to grass, and became as healthy and as fat as any of the flock with which it was associated. Mr. Brookes stated that *prolapsus* is equally frequent in some other animals, and gave the history of a case in which profuse and almost fatal hæmorrhage ensued from cutting away the displaced parts: he fully agreed in the propriety of removing them by ligature.

Mr. Bennett called the attention of the Committee to one of the *Spider-Monkeys,* (*Ateles,* Geoff.,) at present living in the Society's Garden, which he regarded as a new species. He named and characterized it as the

Ateles

Ateles frontalis. *At. ater, maculâ frontali semilunari albâ* Statura *At. atri*, F. Cuv.

By the white patch on the forehead and the radiation of the hair from the back of the neck, this monkey approaches the *At. hybridus*, described in the 'Dictionnaire Classique d'Histoire Naturelle,' by M. Isidore Geoffroy Saint-Hilaire. In the latter, however, the colours of the body are varied and generally light, the darkest tint which is mentioned as occurring on the specimen described being the pure brown of the head and anterior limbs. In the Society's individual, on the contrary, the whole of the hairs, with the exception of the frontal patch, are jet black: the naked parts of the skin are also black, except a flesh-coloured space on the face including the eyes, nose, and lips. It has been suspected that as the lighter-coloured species of *Ateles* advance in age they acquire the black which is so generally prevalent in the group; but this change of colour yet remains to be proved.

Some notes by Mr. Yarrell of an examination of the body of the *lesser American Flying-Squirrel*, (*Pteromys volucella*, Cuv.,) were read. The individual examined had lived in the Society's Collection for upwards of a year.

The pectoral muscles, and also the muscles of all the limbs were well marked and of large size; the clavicles perfect; and the general character of the bones similar to that of the *Squirrels*. The heart was comparatively large, and the lungs were formed of two unequally sized lobes on each side, bearing evident marks of inflammation; the chest was capacious, the diaphragm being situated very low down, and dividing the body into two nearly equal cavities. The liver was composed of six lobes, varying in size, deeply divided, and placed three on each side; the gall-bladder was small, elongated, and collapsed. The stomach in form and position resembled that of the *Squirrel*; it was triangular, the *apex* forming the pyloric portion; the breadth $1\frac{1}{10}$ and 1 inch in depth. The length of the small intestines was $19\frac{1}{2}$ inches; the *cæcum* 1 inch; the *colon* and *rectum* 7 inches; the *cæcum* also resembled that of our *Squirrel* in form, but the membrane connecting its inner surface being more free, the *cæcum* was less curved upon itself. The kidneys measured each $\frac{5}{10}$ths of an inch in length by $\frac{3}{10}$ths in breadth; they were inflamed; and both ureters were also diseased and enlarged. The subject was a female, and the uterine *cornua* measured each 1 inch in length. The whole length of the intestinal canal was 28 inches; the length of the animal from the nose to the origin of the tail $4\frac{1}{2}$ inches.

The stomach, *cæcum*, and portions of the skeleton were laid on the table. Mr. Brookes remarked that the cartilage which, passing from the *carpus*, affords support to the volitant membrane in the *Flying-Squirrels*, is found in all the *Pteromyes* and *Sciuropteri*; but that it does not exist in *Galeopithecus*.

One of the specimens of *Suricate* (*Ryzæna tetradactyla*, Illig.), which were exhibited to the Committee on the 25th January, having died, the following notes respecting its anatomy were read by Mr. Owen.

"The

"The specimen was a female, and measured, from the end of the snout to the vent, 11 inches. On opening the body it was observed that the bile had exuded through the *peritoneum*, and had stained the ensiform cartilage close to which the *fundus* of the gall-bladder lay. The *viscera* of the *abdomen* presented a beautiful appearance when exposed; the liver occupied the hypochondriac and epigastric regions; below this appeared the stomach with its vessels injected, and along the convexity of this organ the spleen swept across the *abdomen* from the left to the right lumbar region; the convoluted intestines occupying the lower part.

"The *œsophagus* has a course of about half an inch in the *abdomen*, and enters the stomach half an inch from the left extremity of that *viscus*. The stomach is of a full oval shape, without any contraction in the middle, and retaining the same circumference to very near the *pylorus*: its longitudinal diameter is 2 inches; its depth 1 inch 10 lines. There is a large *omentum*, broadly attached to the stomach and spleen, which was hidden among the convolutions of the small intestines. The *duodenum* makes a large curve at the right side of the *abdomen*, is a loose intestine throughout its whole course, having a *mesoduodenum* which becomes shorter as it approaches the spine at the lower part of its curve; it is continued into the *jejunum* before it crosses the spine. The small intestine then descends into the left iliac region, makes a sudden turn upwards, and after a few convolutions again at the lower part of the *abdomen*, terminates in the *cæcum* which is situated in the left lumbar region just above the left kidney. The circumference of the small intestines is nearly the same throughout their course, viz. 1 inch; their length 3 feet 2 inches.

"The *cæcum* is nearly an inch in length, with a rounded extremity, and rather contracted at its commencement; but its position and direction are the reverse of the *cæcum* in the human subject, having the blind end pointing to the diaphragm, and lying, as in birds, by the side of the small intestine, and in the direction of the large intestine, which is continued almost straight down to the *anus*. There is not any natural division into *colon* or *rectum*, the large intestine being without longitudinal bands or *sacculi*, and measuring in length only six inches. The circumference is rather more than that of the small intestines.

"The liver is tripartite, with a *lobulus Spigelii*; the right division is bilobed; the middle division has three lobes, with the gall bladder lodged deep in the right fissure, and the coronary ligament in the left; the left division is entire. The gall-bladder is large; it had an irregularly contracted surface. The *ductus choledochus* enters the *duodenum* half an inch from the *pylorus*.

"The *pancreas* has a singular form. A thick transverse portion extends from the spleen behind the stomach to the *pylorus*; it then divides and forms a circle, which lies in the concavity of the great curve of the *duodenum*; sending off one or two processes in the *mesoduodenum*.

"The spleen is a flat elongated body, four inches in length, about an inch in breadth, with the margins irregularly notched; one of these

these is thicker than the other, so as to give it the appearance of a three-sided body. Two large veins go from it to the *vena portæ*; on inflating these, the whole substance rose and became turgid, appearing to be little else than a receptacle for venous blood.

"The kidneys are small oval bodies, having the veins partly ramifying on their exterior, as in the *Civet*, the *Genette*, and the *Cats*.

"The lungs have three lobes on the left side and four on the right, one of which lies in the mesial line behind and below the heart. This single lobe, which is very general in the *Mammalia*, has considerable analogy with the *lobulus Spigelii* of the liver.

"The heart is oblong, with a round obtuse *apex*. The left brachial vein joins the superior *cava*; the arch of the *aorta* gives off the two carotid arteries and the right brachial by a common trunk, then the left brachial artery.

"The rings of the *trachea* are regular and of uniform size, incomplete behind, in number thirty-six. The arytenoid cartilages have thin elevated *apices*. The sides of the *epiglottis* extend backwards as far as the cricoid cartilage, and it arches over the *rima glottidis* like a penthouse or shed. The thyroid gland consists of detached lobes lying below the *larynx*, in the interspace of the *œsophagus* and *trachea*.

"The tongue measures one inch and eight lines; it becomes gradually thinner to the tip, which is neatly rounded. The horny *papillæ* are principally collected in three groups, one near the *apex*, and one on either side near the middle of the tongue.

"The *œsophagus* has longitudinal *rugæ* internally.

"The parts of generation showed, by their vascular condition, evident traces of recent excitement: this individual, indeed, had been observed to receive the advances of the male a short time previous to her death; but there was no visible proof of impregnation having taken place. The *vagina* had longitudinal *rugæ* on its inner aspect; the *urethra* opened close to the external aperture, within a small fold of membrane, but without any appearance of *clitoris*. From the *os tincæ* to the commencement of the *cornua uteri* was half an inch; the *cornua* were an inch in length; the fold of *peritoneum*, or broad ligament, was continued from them as high as the upper part of the kidneys. The fallopian tubes made a turn round the ovaries, their extremities being closely attached to the capsules of these glands. The ovaries themselves were small oval bodies, being about three lines in the long diameter, and were surrounded by a small capsule of *peritoneum*; I observed on one part a small dark coloured speck, which was probably a *corpus luteum*.

"Two small glandular follicles open on either side of the orifice of the *urethra*, and two larger spherical bags open at the verge of the *anus*; these were filled with a white unctuous secretion, which had a faint odour, like the ordinary secretions of *glandulæ odoriferæ*. The quantity of this secretion probably had reference to the condition of the sexual organs before alluded to.

"The principal morbid appearances were in the lungs. They were

were of a dark livid colour, and in a state almost approaching to hepatization. Hurried and impeded respiration was the principal symptom noticed before death. The stomach and small intestines betrayed traces of inordinate vascular action.

"In the structure of the alimentary canal, especially of the *cæcum*, and in the remarkable shortness of the large intestines, this animal has a close affinity with the *Civet* and *Genette*, as well as in the structure of the kidneys as before mentioned. The inferior surface of the *tarsus* is destitute of hair, as in many of the *Viverridæ*, in the true plantigrade *Mammalia*, and in the *Kangaroo;* like the latter animal, the *Suricate* is in the habit of assuming the upright position, resting on the *tarsus*. It is carnivorous, and while in confinement, manifested great agitation at the sight of small birds."

In conclusion, Mr. Owen remarked, that the appearances which he had noticed, agreed with the description of the *viscera* of the animal, as recorded by Daubenton, so far as that distinguished comparative anatomist had observed them.

The Chairman exhibited a collection of Birds which had been made in the island of Mauritius by Mr. Telfair, an active and well known Corresponding Member of the Society. They had been consigned to Mr. Barclay of Bury Hill in Surrey, who had presented them to the Society. Several species were of interest, as being confined to the island and its immediate vicinity, and being uncommon in European collections: and others, although found in Europe, as affording some facts respecting the geographical range of species. Mr. Vigors proposed to lay a catalogue of the collection before the Committee at an early Meeting; and on the present occasion named and characterized the following apparently new species of *Spoonbill*.

Platalea Telfairii. *Plat. corpore unicolore albo, rosaceo leviter tincto; regione circa rostrum, mandibulâ superiori, pedibusque rubris; mandibulâ inferiori nigrescenti, basi flavâ.*

Longitudo *corporis* a mandibulæ basi ad apicem caudæ, $25\frac{1}{2}$; *rostri*, 8; *alæ* a carpo ad apicem remigis 2dæ, 16; *tarsi*, 6; *caudæ*, 6.

The Chairman again resumed the exhibition of the Himalayan birds; and calling the attention of the Committee to the number of species now known to belong to the genus *Lanius* as restricted by modern authors, and to the expediency of subdividing the group according to the modifications of form exhibited in the wings and tail, proposed the following characters as separating the two genera.

Lanius.

Rostrum longitudine mediocre, robustum, compressum, ad basin rectum, ad apicem curvatum, mandibulæ superioris tomiis fortiter emarginatis, dentem conspicuum exhibentibus; *naribus* basalibus, lateralibus, ferè rotundatis, membranâ partim tectis; *rictu* setis rigidis munito.

Pedes mediocres; *digitis* liberis; *acrotarsiis* latè scutellatis.

Alæ subacuminatæ, subbreves; remige primâ brevissimâ, tertiâ longissimâ, cæteris gradatim decrescentibus.

Cauda

Cauda brevis, æqualis aut subrotundata.

Typus genericus, *Lanius Collurio*, Linn.

COLLURIO.

*Rostrum pedes*que ut in genere *Lanio*.

Alæ subrotundatæ, breves; remige primâ brevi, secundâ sequentibus paullo breviore, tertiâ quartâ et quintâ ferè æqualibus longissimis.

Cauda elongata, gradata.

Typus genericus, *Lanius Excubitor*, Linn.

To the latter group the following Himalayan species belong.

COLLURIO HARDWICKII. *Coll. capitis parte anteriore, strigâ per oculos ad collum extendente, alis, caudâque nigris; capitis vertice, corpore infra, maculâ mediâ alarum, caudæ tectricibus, rectricibus duabus lateralibus, cæterarumque, quatuor mediis exceptis, basi apiceque albis; occipite, nuchâ, dorsoque imo albescenti-griseis; dorso medio lateribusque abdominis ferrugineis.*

*Rostrum pedes*que nigri. *Caput* supernè albo nigroque colore in duas ferè partes transversim divisum. Longitudo *corporis*, 8; *alæ* a carpo ad remigem 3tiam, $3\frac{1}{2}$; *rostri*, $\frac{3}{4}$; *tarsi*, $\frac{7}{8}$; *caudæ*, $3\frac{3}{4}$.

Bay-backed Shrike, *Lath.? Gen. Hist. vol.* 11. *p.* 13. *sp.* 6.

This bird appears to be the same as that referred to in Dr. Latham's work, the description of which is taken from one of the drawings of General Hardwicke, to whom the species is inscribed.

COLLURIO ERYTHRONOTUS. *Coll. strigâ frontali per oculos ad medium colli extendente, alis, rectricibusque quatuor mediis nigris; capite supra, nuchâ, dorso superiori, rectricibusque lateralibus pallidè cinereis; corpore infra, alarum maculâ mediâ, remigum interiorum apicibus, rectricum lateralium marginibus omniumque apicibus, albis; scapularibus, dorso imo, abdominisque lateribus ferrugineis.*

*Rostrum pedes*que nigri, illius mandibulâ inferiori ad basin flavescenti. *Striga* per oculos nigra, supra graciliter albo marginata. *Tectrices* alarum inferiores albæ. Longitudo *corporis*, $10\frac{1}{2}$; *alæ* a carpo ad apicem remigis 3tiæ, $3\frac{3}{4}$; *rostri*, $\frac{7}{8}$; *tarsi*, $1\frac{1}{8}$; *caudæ*, $4\frac{1}{2}$.

This bird was observed to bear a great resemblance to the description of the *grey-backed Shrike* of Dr. Latham, (*Gen. Hist. vol.* ii. *p.* 9. *sp.* 3.) but to differ from it in the colours of the lesser wing-coverts and tail; the former being all black in the Himalayan species, and blue-grey, ending in pale rufous in Dr. Latham's, while the tail in the former species had four black middle feathers and the rest cinereous, but in the latter had the two middle ones only black, the rest being white. In a group exhibiting so much similarity in the disposition of the colours as the present, such differences are material as distinguishing species.

COLLURIO TEPHRONOTUS. *Coll. fasciâ frontali pergracili ad medium colli per oculos latiùs extendente nigrâ; capite, nuchâ, scapularibus, dorsoque saturatiùs cinereis; collo anteriori pectoreque albescentibus, hoc fusco graciliter fasciato; abdomine crissoque ferrugineis; alis caudâque brunneo-fuscis, apicibus pallidioribus;*

dioribus; dorso imo tectricibusque caudæ superioribus subrufescentibus.

Tectrices alarum inferiores ferrugineo fuscoque notatæ. Statura paullo minor quàm in specie præcedenti.

This bird also was observed to be closely allied to the last, and to differ from it probably only in sex or age. Until such points however could be ascertained, it was considered advisable to regard it as specifically distinct.

Another interesting modification of form was exhibited among the *Shrikes*, in which the forked tail, acuminated wing, and short and feeble legs of the birds allied to *Dicrurus* appeared united to the head and bill of some of the *Stares*, particularly the genus *Pastor*. Mr. Vigors characterized the form under the generic name of

Hypsipetes.

Rostrum subelongatum, debile, parum curvatum, apice leviter emarginatum; *naribus* basalibus, lateralibus, longitudinalibus, membranâ partim clausis; *rictûs* setis paucis, parum rigidis.

Alæ subelongatæ, subacuminatæ; remige primâ brevi, secundâ longiori septimæ æquali, tertiâ et sextâ æqualibus, quartâ et quintâ æqualibus longissimis.

Pedes brevissimi, debiliores; *acrotarsiis* scutellatis.

Cauda subelongata, forficata, rectricibus extrorsum spectantibus.

Hypsipetes Psaroïdes. *Hyps. capite supra subcristato, remigum apicibus, rectricibusque nigris; corpore alisque cineraceo-griseis; abdomine imo crissoque pallidioribus.*

*Rostrum pedes*que flavi. *Tectricum* alarum *remigum*que pogonia interna fusca. *Tectrices* alarum inferiores cineraceo-griseæ. Longitudo *corporis*, $11\frac{1}{2}$; *alæ* a carpo ad apicem remigis 3tiæ, 5; *rostri* 1; *tarsi*, $\frac{5}{8}$; *caudæ*, $4\frac{1}{4}$.

The following species were also exhibited and described.

Muscipeta brevirostris. Mas. *Musc. capite, collo, nuchâ, dorso superiori, alis, rectricibusque mediis splendenti-nigris; corpore infra, dorso imo, pteromatum apicibus, fasciâ remigum, rectricibusque lateralibus splendidè coccineis; rostro brevi, subdebili.*

Fœm.? *Fronte, corpore infra, dorso imo, fasciâ alarum, rectricibusque lateralibus flavis; capite, nuchâ, scapularibus, dorsoque superiori griseis; alis rectricibusque mediis nigris.*

Longitudo *corporis*, $8\frac{1}{2}$; *alæ*, $3\frac{1}{2}$; *rostri*, $\frac{7}{16}$; *tarsi*, $\frac{5}{8}$; *caudæ*, 4.

Carduelis spinoïdes. Mas. *Card. fronte, occipite, collo corporeque infra, ptilis, pteromatum apicibus, fasciâ remigum, rectricumque lateralium basibus flavis; capite supra dorsoque olivaceis; alis caudâque fuscescenti-nigris.*

Fœm.? *Coloribus minùs saturatis; abdomine dorsoque olivaceo-fusco striatis.*

Statura paulò major quàm *Card. Spini.*

Picus auriceps. Mas. *Pic. capite supra aureo; occipite, abdomine imo, crissoque coccineis; colli parte posteriori et strigâ utrinque laterali, corporeque supra nigris; colli parte frontali et lateribus, corporeque infra albis, hoc nigro striato; scapularibus, pteromatibus,*

tibus, remigibus, rectricibusque lateralibus albo-maculatis; dorso medio griseo, albo nigroque fasciato.

Fœm. *Sine notâ coccineâ occipitali.*

Statura *Pic. medii.*

Picus pygmæus. Mas. *Pic. capite supra dorsoque medio griseo-canis, hoc albo nigroque fasciato; strigâ utrinque per oculos ad nucham extendente, gulâ, maculisque pteromatum remigum et rectricum lateralium albis; pectore abdomineque albescentibus, fusco graciliter striatis; notâ longitudinali gracili utrinque post oculos coccineâ.*

Fœm. *Sine notâ coccineâ postoculari.*

Statura minor quàm *Pic. minoris.*

The male exhibited of this species was observed to have the two middle tail feathers elongated beyond the rest, and the lateral feathers were shown to be altogether soft and flexible, like those of the genus *Picumnus,* Temm.

Cinnyris Gouldiæ. *Cinn. capite supra, gulâ colloque in fronte, regione auriculari, strigâ utrinque gracili ad latera colli usque ad humeros extendente, uropygio, caudæ tectricibus, rectricibusque duabus mediis elongatis purpureo et cœruleo metallicè splendentibus; capitis lateribus, occipite, nuchâ, scapularibus, dorso summo, ptilisque sanguineo-rubris; dorso imo, pectore, abdomineque sulphureis, his sanguineo sparsis; remigibus rectricibusque lateralibus fuscis.*

Longitudo circiter 5 uncias.

Mr. Vigors expressed the pleasure which he felt in dedicating this species to the accomplished artist, Mrs. Gould, who executed the plates of these Himalayan birds.

March 8, 1831. Sir Thomas Phillips, Bart. in the Chair.

The Report on the animals for the importation of which the Council should be recommended to take measures (prepared in pursuance of a Resolution of the Committee, Jan. 11.), was presented and read by Mr. Vigors. It was directed that it should be suspended in the Meeting Room for the consideration of the Members of the Committee until the next Meeting, to which it shall be again submitted, and its adoption be recommended.

An extract was read from the 'Lecture faite à la 1ère Séance Annuelle de la Société d'Histoire Naturelle de l'Isle Maurice, 24 Aout, 1830, par M. Julien Desjardins, Sécretaire de la Société,' a manuscript copy of which had been transmitted by that Society.

The zoological labours of the Mauritius Natural History Society have, during the first year of its existence, embraced numerous departments of animated nature.

The *Mammalia* of the island have been treated of by M. J. Desjardins. They are twenty-six in number, of which twelve only exist in the wild state. These are enumerated as the *Simia Aygula,* L.; *Pteropus vulgaris*; *Pter. rubricollis,* Geoff.; *Nyctinomus acetabulosus,* Geoff.; *Taphozous Mauritianus,* Geoff.; *Erinaceus setosus,* L.; *Sorex Indicus,* Geoff.; *Mus Rattus,* L.; *Mus Musculus,* L.; *Lepus nigricollis*; *Sus scrofa,* L.; and *Cervus Elaphus,* L.

Various

Various *Birds* of Mauritius have been brought before the Society, including the *Fulica Chloropus*, L.; the *Numenius Madagascariensis*, Briss.; and a *Snipe*, known in the island as the *Cul blanc*. To the latter M. L. Desjardins has given, with some doubts, the name of *Scolopax Mauritiana*.

Several birds from Madagascar have also occupied the attention of the Society, and M. J. Desjardins has identified them as follows: two species of *Falco*, Cuv.; *Strix flammea*, L.; *Loxia Madagascariensis*, L.; *Corvus Dauricus*, Lath.; a species of *Regulus*, Cuv.; *Cuculus canorus*, L.; *Tetrao Coturnix*, L.; *Scopus Umbretta*; *Rallus Madagascariensis*, n. s.; *Fulica Chloropus*, L.; *Fulica cristata*, Gmel.; *Scolopax Capensis*, L.; *Colymbus minor*, L.; and four species of the genus *Anas*, L.

There are very few *Reptiles* met with on the island. An instance has occurred of the discovery of a living *Snake*, the second within the memory of the inhabitants. It was the *Coluber rufus*, LaCép.; and had probably been brought from India in some ship. The earlier travellers speak of the existence of *Tortoises*, but none are now found. M. J. Desjardins has, however, discovered three deposits of the remains of these animals, all of which are evidently of modern date, their age not exceeding two or three centuries. There are two *Saurian Reptiles*, which, although common, remained undescribed until M. L. Desjardins gave to them the names of *Scincus Telfairii* and *Scinc. Bojerii*: he has also described a third, smaller and much more uncommon than the others, the *Scinc. Boutonii*.

Three new species of *Fishes* have been described and figured by M. T. Delisse. They are a *Heniochus*, Cuv.; a *Holacanthus*, Cuv.; and an *Ophidium*, L.

In *invertebrated animals*, especially those which inhabit the sea, Mauritius is rich. Among the *Annelida*, M. Liénard, sen. has described an *Amphitrite*, which he believes to be new: he has also described the *Amph. voluticornis* and *Amph. splendida*, Lam., together with three new species, the *Amph. fuscata*, *albicans*, and *tricolor*. A lacustrine *Erpobdella* has been described by M. L. Desjardins, who has preserved to it the trivial name of *sex-lineata*, doubtingly given by MM. Quoy and Gaimard. Three new species of *Crustacea*, of the genera *Lupa*, *Plagusia*, and *Cancer*, have been described by M. Liénard, jun.: and M. De Lisse, sen., has proposed to regard as the type of a new genus the *Homard sans cornes* of the fishermen; to this group he gives the name of *Scyllibacus*, and places it between *Scyllarus*, Fab. and *Ibacus*, Pér. The species is named *Scyllibacus orientalis*. Many *Insects* have been exhibited at the meetings of the Society, and M. J. Desjardins has read a description and history of the metamorphoses of the *Coccinella sulphurea*, Oliv. Among the *Cirrhipeda* a new species of *Anatifa*, allied to *An. striata*, Lam., has been described by M. Desjardins under the name of *An. Mauritiana*.

The *Radiata* which have been described, are a species of *Fistularia*, Lam., and a new species of *Cephea*, the *Ceph. lamellosa*, so named by M. Liénard, jun. on account of the foliaceous *lamellæ* which cover the under surface of its arms.

Among

Among the *Mollusca,* six species of *Doris* have been described by M. Liénard, sen., to one of which, regarded by him as new, he has given the name of *Dor. marginata.* The same gentleman has also described a *Pleurobranchus.* M. Liénard, jun. has described another species of *Doris,* and has given a description of a *Dolabella,* with an account of its anatomy.

Such is a brief outline of the zoological labours of the Mauritius Natural History Society, which within the short period of its existence has received no less than fifty memoirs, descriptions, and notices on different branches of natural science.

At the request of the Chairman, Mr. Martin read his notes of the dissection of a specimen of the *Testudo Indica,* L., which recently died at the Society's Gardens.

The animal was of large size, although considerably less than one formerly in the possession of the Society, the dissection of which, by Mr. Yarrell, has been published in the Zoological Journal. The *carapace* or dorsal shell measured 2 feet 11 inches in length, and the *plastron* or ventral shell 2 feet 4 inches. The breadth was 1 foot 9 inches.

The length of the stomach was 2 feet; the circumference in the largest part 1 foot 3 inches; its shape a flattened oval, contracting gradually towards the *pylorus.* On opening it, the coats, and especially the middle or muscular, were found extremely thick and firm, and increasing in thickness towards the *pylorus,* which protruded in a singular manner, to the distance of nearly an inch into the *duodenum,* at which part a few longitudinal *rugæ* were observed, the rest of the lining membrane being perfectly smooth. It contained a little fluid only. The liver presented nothing remarkable; it consisted of two principal lobes, in the right of which the gall-bladder was buried, so as just to show itself; the length of the gall-bladder was 2 inches.

The small intestines were thick and firm, their length being 3 feet 6 inches. The gall-duct enters the *duodenum* 3 inches, and the pancreatic duct 10 inches, below the pyloric orifice. On laying open the small intestines, their lining membrane appeared corrugated with numerous longitudinal *rugæ,* and they were found perfectly empty.

The large intestines were smooth on their internal surface, and filled with an immense mass of condensed vegetable matter, which was green and fibrous, and appeared to have only partially undergone the process of digestion. In the *colon* near the entrance of the small intestines were two or three small black patches, seemingly gangrenous. There was no *cæcum.* The circumference of the *colon* measured 9 inches. The length of the large intestines was 6 feet 8 inches, exclusive of the *cloaca,* which was 1 foot.

At the lower part of the *abdomen,* (in a singular cavity, formed by a diaphragm-like expansion of *peritoneum,* from which, to the opposite or extreme side, passed numerous bands, bearing a resemblance to the *chordæ tendineæ,*) the urinary bladder, of enormous capacity, was lying loose, irregularly folded, but containing a considerable quantity of viscid fluid: its *parietes* were thin, but very fibrous in texture.

When

When moderately distended with air, its shape was made manifest, as trilobed, or rather, as consisting of one large central bag, from each side of which, a conical process jutted out; the extent from point to point being 1 foot 10 inches. It opened by a neck of about 3 inches in length, and closely invested with lung, into the *cloaca*, about 6 inches from its termination; the *penis* was long and deeply furrowed, and the *glans* large at the base, with a pointed *apex*.

The lungs were very florid in colour, and extremely light, spongy, and cellular, the cells being large and distinct. They extended the whole length of the *carapace*.

The kidneys were situated at the back of the *abdomen*, in shape oval; flat on one side, convex on the other; about 5 inches long, 2½ inches broad, and consisting of numerous lobes, which gave to their surface a furrowed or brain-like appearance; the relative proportion of the venous ramification in them was found to exceed that of the arterial.

As regards the death of the animal, nothing positive could be determined; but it appeared to Mr. Martin, from the black patches about the *colon*, and the quantity of undigested matter in the large intestines, to have resulted principally from an unnatural accumulation of fæcal matter, and the attending evil consequences.

GEOLOGICAL SOCIETY.

March 2nd.—A paper was first read On the rippled markings of many of the forest marble beds north of Bath, and the *foot-tracks* of certain animals occurring in great abundance on their surfaces. By George Poulett Scrope, Esq., F.G.S., F.R.S.

The wavy and wrinkled figuring of these and other sedimentary strata, the author considers to be identical in all its various accidents, as well as in its origin, with the markings of the sea-sands exposed at low tide on many of our shallow shores. He attributes it to the vibratory movement of the lower stratum of water, when agitated by winds or currents, by which sediment, either in the act of precipitation or stirred up from the bottom, is led to arrange itself in ridges corresponding to the intervals between the contiguous arcs of oscillation.

Since it cannot be supposed that such movements reach to any very considerable depths, these ripple-marks make it probable that the beds in which they occur were formed on a shallow shore; and this idea is further confirmed, and their analogy with the littoral deposits of our modern coasts brought still closer, by their composition of rolled fragments of shells, of corals, spines of echinus, and crustacea, by the imbedded remains of fuci, and above all by the frequent intersection of their surfaces by the sharp well-defined and fresh-looking *tracks of some small animal*, impressed upon the sand, apparently when left dry by the ebbing of the tide.

Here then, says the author, we have brought together in the compass of a small slab, several interesting memoranda of the day, however distant, when the waves of the ocean were beating against

a line

a line of coast now in the centre of our island; and a new class of facts to assist in better deciding the question as to the date of emergence of the different successive formations from the bosom of the deep.

Mr. Scrope does not hazard a conjecture respecting the genus or even the class to which the animal may have belonged; leaving it to zoologists to determine whether it be marine, terrestrial, or amphibious. He, however, earnestly recommends geologists in every quarter of the globe to examine minutely the surface of sandstones, and other sedimentary strata, particularly where ripple-marked or alternating with clay seams (which effectually preserve the surface in all its original freshness), little doubting that the result will be to throw much new light on the early history of our planet, and on the habits and characters of its successive races of animated inhabitants.

The reading of a paper, entitled "A description of longitudinal and transverse sections through a portion of the carboniferous chain between Penigent and Kirkby Stephen," by the Rev. Adam Sedgwick, F.G.S., F.R.S., Woodwardian Professor in the University of Cambridge,—was begun.

March 16.—The reading of the paper by the Rev. Professor Sedgwick, begun at the last Meeting, was concluded.

The author having in a former paper (read Jan. 5th, 1831*) described some of the characters of the great central carboniferous chain of the North of England, here describes, in great detail, the composition of a very remarkable portion of it, which forms a connecting link between the structure of the High Peak of Derbyshire and the region of Cross Fell. The principal section, commencing at the top of Penigent in Hocton parish, passes over the highest mountains of the chain, and ends in the valley of the Eden, near Kirkby Stephen, among the conglomerates of the new red sandstone. From the top of Penigent and of Whernside, branch out two other sections connecting the mountains along the principal line, with those which range between Wensleydale and Swaledale. The successive groups of strata appearing along these lines are described in the ascending order, and their modifications in the successive valleys where they crop out are shortly noticed.

It is impossible to notice the seventeen groups enumerated in this paper; but they may be subdivided more simply into three principal groups as follows:

1st. Great scar limestone; the maximum thickness of which is more than 500 feet. The author compares this group with the limestone of the High Peak, and shows that they have many characters in common. He particularly notices the reciprocating wells and caverns, about the origin of which he briefly speculates. He notices the chief changes of mineralogical character; and states that among the very rare fossils of the mountain limestone, Ammonites, Trilobites, and Orthoceratites, appear to be confined to this group. He further states, that although carbonaceous and bituminous

* See Phil. Mag. and Annals, for March, p. 211.

matter are the colouring principle of the limestone strata in this group, there are no workable beds of coal subordinate to it on any of the lines of section.

2nd. The next great group comprehends no less than eleven groups of the author's sections, and in several mountains is more than 1000 feet in thickness. It is essentially composed of mountain limestone, sandstone, and shale. The limestone groups are stated to be five in number, and to be very remarkable for their regularity in all the various sections: the lowest contains the black compact beds now extensively quarried in the North of England for marble; the highest group represents the twelve-fathom-limestone of the mining districts; it contains beds made up of an incredible number of encrinital stems, and is also quarried for marble. The shales are carbonaceous, and contain three or four beds of coal, some of which are of good quality, and are extensively worked for domestic use: the most remarkable of these beds occurs under the twelve-fathom-limestone.

3rd. The highest complex group includes all the deposits connected with the millstone grit, and is stated to be more than 500 feet in thickness. It includes three distinct deposits, to which the author gives the name of millstone grit; and several beds of carbonaceous shale, one of which contains a bed of coal three feet thick and of good quality. Besides this there are one or two other coal-beds, but of very inferior value, seen here and there along the lines of section.

After entering on many minute details, which it is impossible to notice in this abstract, the author describes five transverse sections, drawn nearly east and west from different points in the principal line of section across the prolongation of the great Craven fault, described in a former paper. By the help of these sections he points out the peculiar relative movements of the grauwacké and carboniferous chains during the period of elevation which preceded the new red sandstone. At the foot of Barfell, above Sedburgh, a mass of the carboniferous system, six or seven hundred feet in thickness, has been torn up from the foundations of the mountain and placed in an inverted position.

From all the previous details the author draws a series of conclusions, and shows:

1st. That the region described in the paper, forms a connecting link between the northern and southern ends of the carboniferous chain; and that the carbonaceous deposits are gradually more and more interlaced with the limestone in the range towards the north.

2ndly. That many of the coal-beds alternating with the mountain limestone must have been deposited in the waters of a deep sea; that no fresh-water shells appear associated with the fossils of these beds; and that the highest part of the Yorkshire coal-fields was probably deposited in shallow bays and estuaries, inasmuch as Pectens and Ammonites are there found associated with fresh-water genera.

3rdly. That, with limited exceptions, the same species of fossils are found in all the beds of limestone; but wherever there is a change of

of mineral character, that there we may remark an equally sudden change in the fossil species. Thus the vegetable impressions abounding in the sandstone and shale are not found in the limestone; on the contrary, the corallines, encrinites, &c. of the limestone, with rare exceptions, do not occur in the shale or sandstone beds.

4thly. That the beds of limestone appear to have been formed by a slow and tranquil deposit, assisted by the action of organic bodies, which lived and died on the spots where they are now found; that on the contrary, the beds of shale and sandstone appear to have been formed mechanically, and contain fossils drifted from a distance. Hence these beds are less continuous and regular than the groups of limestone; but some of them, especially two of the coal-beds, may be traced through the greater part of the several lines of section.

5thly. That the valleys of the carboniferous chain, near the lines of section, are not excavated on lines of fault, but on true valleys of denudation. Notwithstanding this, there has been some change in the distribution of the water channels, at a period very recent, compared with that of the elevation of the carboniferous chain—just before the deposit of the new red sandstone.

March 30th.—A paper was read, entitled "Geological remarks on the vicinity of Swan River and *Isle Buâche* or Garden Island, on the coast of Western Australia; by the Rev. Archdeacon Scott, F.G.S."

The author, who was accidentally detained for several months at the settlement recently established on the western side of Australia, describes a line of coast, of more than thirty miles in length, as composed of a highly calcareous sandstone, presenting very similar mineralogical characters throughout its whole extent. At a promontory, about five miles to the north of the river Swan, the calcareous sandstone exhibits a surface in which are numerous concretions having the appearance of inclosing vegetable matter. This character is by no means confined to that spot, but is very commonly observed; and on a rising ground, to the east of a space marked out for the intended town of Fremantle, the sandstone assumes the appearance of a thick forest, cut down about two or three feet from the surface, so that to walk on it becomes extremely difficult, and even dangerous.

The author gives a detailed account of the sections which accompany the paper, and notices the beds passed through in sinking various wells in the calcareous sandstone.

At Mont Eliza, which rises above Perth, ten miles from the mouth of the Swan, and the principal place in the settlement, the calcareous sandstone attains the height of about 300 feet, and is observed to be based upon a ferruginous sandstone fitted for the purposes of building. From Perth to the foot of Darling's Range, red clay and white marl are found after passing the Helena River. Darling's Range is estimated at about 1500 feet above the level of the sea, and is composed, where visited, of greenstone and sienite;

 and

and he was also informed that clay-slate had been discovered more to the southward in the same range.

Isle Buâche, or Garden Island, consists of the same highly calcareous sandstone which forms so considerable a portion of this part of the Australian coast.

FRIDAY-EVENING PROCEEDINGS AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

Jan. 21.—Mr. Faraday on a peculiar class of Optical Deceptions: —These deceptions depend principally upon the general effect produced upon the eye when two or more bodies are presented in such rapid succession to it as to produce no distinct impression for each, but produce a general impression often very clear and distinct in appearance, but entirely unlike the real appearance of the active bodies. Thus, if two equal cog-wheels be placed one before the other, and put in rapid motion in opposite directions but with equal velocities, a spectral fixed cog-wheel will appear; although if either cog-wheel be looked at alone, nothing but a plain uniform tint, corresponding to the place of the cogs will be seen. The various deceptions depending upon this effect were traced and illustrated, and it appears that many of them are of common occurrence.

In the Library numerous Wheel-animalculæ were exhibited by powerful microscopes belonging to Cuthbert and Varley, for the purpose of illustrating the appearances, which were referred to the class of deceptions above spoken of.

Jan. 28.—Mr. Ainsworth entered into a geological investigation of the methods of determining the ages of the rocks considered as of igneous origin, from a consideration of their composition and structure.

Feb. 4.—Mr. Brande discussed the relation of the vegeto-alkalies to the common alkalies, and to certain proximate principles of vegetables. After briefly stating what Davy had done in decomposing the alkalies and alkaline earths, he proceeded to detail the exertions made by himself and others to obtain anything analogous to a metallic base from those alkaline bodies which were known to be compounds of elements not metallic. All exertions of this kind had failed; but as to the effect of the Voltaic pile upon the salts of the vegeto-alkalies, it was precisely the same as upon the metallo-alkaline salts, the base proceeding to the negative pole, and the acid to the positive pole. The properties of the new febrifuge principle *Salicine* were dwelt upon, and also a new vegeto-alkali discovered by Mr. Hennell, but not yet described, namely, *Elateria*.

Feb. 11.—Mr. Harris of Plymouth gave an account of certain investigations which he had made relative to the power possessed by different bodies of intercepting magnetic action, and showed the experiments by which the existence of such power was proved, and its force estimated. Thus it has been supposed that iron had an intercepting power, but copper, and many other metals and substances, none. He found, however, and showed, that when the copper, silver, zinc, or other substance interposed was in sufficient quantity, these metals also

also intercepted the magnetic influence; and in a ratio corresponding with that in which different bodies in rotation are affected by or affect a magnet. The results of these and other modes of investigation were fully described.

Feb. 18.—Mr. Faraday gave an experimental account of the new substance discovered by M. Dumas, and called by him *oxamidi* or *oxalamidi*. See our present volume, p. 67.

Feb. 25.—Mr. Cowper exhibited models of, and described the most recent improvements in, paper-making; and especially his own machine for cutting paper made in sheets of unlimited extent into such as were of proper size for ordinary uses. Some extraordinary advantages of the powers of mechanism in paper-making and printing were developed and illustrated in the course of the evening.

In the Library was placed a beautiful series of anatomical models in wax by M. Schloss.

March 4.—Dr. Edmund Clarke gave an account of the present state of Vesuvius and of Pompeii. This gentleman has ascended that volcano several times, and attended particularly to its natural history: the results of his observations were communicated in this evening's discourse, and illustrated by many specimens of minerals, plants, &c., and by numerous drawings.

March 11.—The beautiful machinery employed by Mr. Mordan in the manufacture of pencils of the ordinary construction, the points for the ever-pointed pencil, and the Bramah pens, was arranged in the Lecture-room in perfect working-order, and the operations were all explained by Mr. Ainger, whilst they were performed by Mr. Mordan's men.

In the Library, amongst many other objects of interest, was a peculiar mountain barometer invented by Robinson, which could be divided in halves and packed in a case not more than sixteen inches long. There was also a portable transit instrument by the same maker.

March 18.—The subject this evening was the Elasticity of matter in general; particularly the elasticity of torsion in threads of glass; with the application of this property to delicate physical research. Mr. Ritchie, who treated this subject, resumed and illustrated what he has already published upon it in the Philosophical Transactions, adding several very beautiful experimental demonstrations of certain physical laws which have been established by mathematical calculation.

March 25.—Mr. Faraday spoke on Light and Phosphorescence; his object being to introduce to the members of the Royal Institution certain experiments recently made in the laboratory by Mr. Pearsall, the Chemical Assistant, in which, after bodies phosphorescent by heat, such as apatite, chlorophane, &c. &c. had been deprived, by strong calcination, of their power of emitting light, it was proved that it could be restored to them again. This was effected by passing ten or twelve strong electrical discharges over them, and it was observed, that at the same time there was a tendency to the restoration of the colour of the fluor spar.

Specimens

Specimens of well-manufactured New Zealand flax were in the Library, with various chemical apparatus, &c.

The meeting was then adjourned over two Fridays, to the 15th of April.

CAMBRIDGE PHILOSOPHICAL SOCIETY.

A meeting of this Society was held on Monday evening, February 21, Dr. F. Thackeray, the Treasurer, in the chair. Various books were presented to the Society, among which were three volumes of the *Correspondance Mathematique et Physique*, published by M. Quetelet, of Brussels, and presented by him; Dr. Morton's Travels in Russia, from the author, and a Russian Dictionary presented by the same gentleman; Mr. Jones's new work On the distribution of Wealth, from the author; The second edition of the first volume of the Translation of Niebuhr, from the translators. The following presents to the museum were also announced:—several skins of birds and a collection of insects from China, presented by the Rev. G. Vachell; a collection of foreign insects, by J. G. Children, Esq.; and two specimens of Charr from Wales, by W. Yarrell, Esq. A Daniell's hygrometer was presented by R. W. Rothman, Esq. Fellow of Trinity College. W. Swainson, Esq. well known as an ornithologist, was elected an honorary member.—A paper was read by Professor Airy, "On the nature of the rays formed by the double refraction of quartz;" of which the following is an abstract:—

It is well known to those who have followed the recent discoveries respecting the properties of light, that the phænomena exhibited by quartz are very different from those of any other substance of similar crystalline character—as for instance, calc spar. Thus, when exposed to plane-polarized light, a plate of calc spar exhibits a series of rings, of which the colours commence from Newton's black at the centre; and these rings are intersected by a black cross:—quartz, on the other hand, displays a series of rings, the central point of which exhibits a colour different according to the thickness of the plate: there is no cross, but at a distance from the centre, rudiments of black brushes begin to appear. Again, in the case of calc spar,—on turning the analysing plate, the rings change in colour, but are always circular, and of unchanged dimensions. On turning the analysing plate in the experiment with quartz, the rings become square figures, with a curious defect of symmetry, and dilate or contract continually. If we put together a plate of right-handed and a plate of left-handed quartz in the same apparatus, we obtain a most singular and beautiful appearance, consisting of four coloured spirals cutting a number of concentric circles.

On exposing these substances respectively to light circularly-polarized, the appearances are still more remarkable: calc spar exhibits rings dislocated at each quadrant, with a gray cross; while the colours in quartz are seen in the form of two spirals inwrapping each other, with no black or gray cross.

Professor Airy, after describing these phænomena, the most striking of which are new, proceeds to state and develop the hypothesis

pothesis which they have suggested to him; of which the main point is this: that the two rays in quartz are elliptically-polarized, one to the right, the other to the left; the major axes of the ellipses being respectively in and perpendicular to the principal plane. Calculations founded on this supposition represent with a very close agreement, the various and complex phænomena which have been noticed; and, what is more remarkable still, they not only coincide in the general facts, but lead also to deviations from symmetry, such as are observed to exist in the figures.

After the meeting, Professor Airy exhibited, 1st, A model to illustrate Fresnel's idea, that circularly-polarized light is formed from plane-polarized (when the plane of polarization is inclined 45° to that of total internal reflexion), by retarding the undulations perpendicular to the plane of reflexion by one quarter of an undulation; and that double such a retardation shifts the plane of polarization 90°;—which was also shown to be the fact with Fresnel's rhomb.

2d, A new polarizing machine: the advantages of which are;—that complete rings may be seen with a very small specimen: that by placing the specimen in another position, the macled structure may be very well seen: that circularly-polarized light may be used as well as plane; and that lamp-light may be used as well as daylight.

3d, An attempt to exhibit the coloured rings by the light of heated lime; which succeeded so far as to show the practicability of this application.

March 7.—The Very Reverend the Dean of Peterborough, the President, in the chair.—The following presents were laid on the table: A pair of the Scaup Duck (*Fuligula Marila*), by the Hon. Richard Neville; An egg of the Cayman, presented by Dr. Jermyn; and an egg of the Great Bustard, found in Cambridgeshire, presented by Mr. Barron. A paper was read by R. Murphy, Esq. Fellow of Caius College, "On the general solution of equations." After the meeting, the Rev. R. Willis, of Caius College, exhibited a number of experiments on the transverse and longitudinal vibrations of strings, membranes, and solid bodies, illustrative of the recent researches and discoveries of M. Savart.

March 21.— Dr. F. Thackeray, the Treasurer, in the chair. A paper by Mr. Miller, of St. John's College, was read, "On the elimination of the time from the differential equations of the motion of a point, acted upon by a central force, and affected by disturbing forces, or by the resistance of a medium." A paper, by the same gentleman, was also read, containing Determinations of the form and measurements of the angles of several artificial crystals; viz. sulphuret of nickel, borate of potash, nitrate of ammonia, carbazotic acid, carbazotate of potash, benzoic acid, nitrate of silver and ammonia, and sulphate of copper and ammonia. The latter compound appears, by comparison with the measurements of Mr. Brooke, to be isomorphous or plesiomorphous with respect to various other double sulphates; viz. the sulphates of ammonia and magnesia,

magnesia, of nickel and potash, of nickel and zinc, of potash and magnesia, and of copper and potash.—After the meeting, Mr. Willis exhibited a machine constructed for the purpose of illustrating the motions of the particles of a fluid in which undulations of various kinds are singly or jointly propagated.

April 18.—The very Rev. the Dean of Peterborough, the President, in the chair. The first part of a paper by Professor Whewell was read, containing A mathematical exposition of some of the leading doctrines of Mr. Ricardo's "Principles of Political Economy and Taxation." There was also read, by Professor Airy, A description of an apparatus constructed under his direction, and of the properties of elliptically-polarized light exhibited by means of it; it was stated that the phænomena had been found to agree in the most precise manner with the results previously obtained by calculation.—After the meeting, Professor Henslow exhibited a number of the appearances of what have been called "spectral wheels," produced by the rotation of two wheels, one behind the other.

LVIII. *Intelligence and Miscellaneous Articles.*

FALL OF THE BROUGHTON SUSPENSION BRIDGE, NEAR MANCHESTER.

We have been favoured by an esteemed correspondent at Manchester, with some extracts from the Manchester Chronicle and Manchester Guardian newspapers, of April 16th, respecting the giving way of a suspension bridge over the river Irwell, at Broughton, about two miles from Manchester. Our correspondent informs us that the editors of both papers have been at great pains to investigate the circumstances. Both give the same account, substantially, of the accident and of its causes. The following particulars are chiefly extracted from the Manchester Guardian, with some additions from the Manchester Chronicle.

A very serious and alarming accident occurred on Tuesday, April 12th, in the fall of the Broughton suspension bridge, erected a few years ago by John Fitzgerald, Esq., whilst a company of the 60th Rifles were passing over it; and, although fortunately no lives were lost, several of the soldiers received serious personal injuries, and damage was done to the structure, which will require a long time and a very considerable expense to repair.

It appears that, on the day when this accident happened, the 60th regiment had had a field-day on Kersall Moor, and about 12 o'clock were on their way back to their quarters. The greater part of the regiment is stationed in the temporary barracks in Dyche-street, St. George's Road, and took the route through Strangeways; but one company, commanded, as it happened singularly enough, by Lieut. P. S. Fitzgerald, the son of the proprietor of the bridge, being stationed at the Salford barracks, took the road over the suspension bridge, intending to go through Pendleton to

to the barracks. Shortly after they got upon the bridge, the men, who were marching four abreast, found that the structure vibrated in unison with the measured step with which they marched; and as this vibration was by no means unpleasant, they were inclined to humour it by the manner in which they stepped. As they proceeded, and as a greater number of them got upon the bridge, the vibration went on increasing until the head of the column had nearly reached the Pendleton side of the river. They were then alarmed by a loud sound something resembling an irregular discharge of fire-arms; and immediately one of the iron pillars supporting the suspension chains, viz. that which was to the right of the soldiers, and on the Broughton side of the river, fell towards the bridge, carrying with it a large stone from the pier, to which it had been bolted. Of course that corner of the bridge, having lost the support of the pillar, immediately fell to the bottom of the river, a descent of about sixteen or eighteen feet; and from the great inclination thereby given to the road-way, nearly the whole of the soldiers who were upon it were precipitated into the river, where a scene of great confusion was exhibited. Such of them as were unhurt got out as well as they could, some by scrambling up the inclined plane which the bridge presented, and others by wading out on the Broughton side; but a number were too much hurt to extricate themselves without assistance, which was immediately rendered by their comrades.

The company consisted of seventy-four officers and privates; and of these about sixty, including one officer (Lieut. Fitzgerald), were upon the bridge at the time; the remainder had not reached the bridge, and were left standing on the Broughton side, when the bridge gave way. Lieut. Fitzgerald being on a line with the leading file, had nearly reached the Pendleton side, where of course the inclination of the road-way was not so great as it was nearer the Broughton side. He, and a few of the men near him, did not fall from the bridge, being merely thrown down on the road-way, but upwards of forty men were either precipitated into the water, or thrown with great violence against the side chains of the bridge. Of these, more than twenty received injuries of different kinds, six were so much hurt that it was found necessary to procure two carts (some of the men being taken out on one side and some on the other), for the purpose of sending them to the barracks. Four of them, whose injuries are of a very serious nature, still (April 16th) remain in the hospital.

As the bridge, in the inclined position into which it was thrown by the accident, blocked up a considerable portion of the water-way of the river, and it would inevitably have been carried away in case of a flood,—a number of men were promptly set to work to dismantle the flooring at the end which had fallen down, which has been completely effected; and preparations are now making to repair the injury which the structure has received from this alarming accident, and at the same time to remedy some defects in its construction, by which the risk of future accidents will be avoided.

Causes of the Accident.—As we conceive the public have a right to be fully informed with respect to the causes of an accident of this alarming nature, we have made some particular inquiries on the subject, the results of which we shall lay before our readers; not only that they may form an opinion upon this particular case, but also that they may be enabled to judge how far it is calculated to render doubtful the security of structures of this kind,—a considerable number of which have now been erected in different parts of the kingdom.

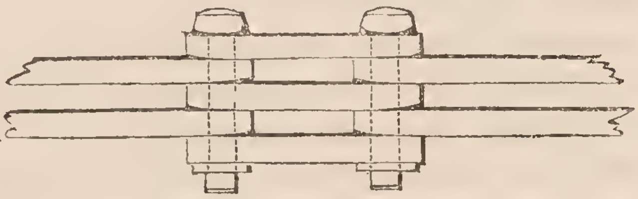
Immediately after the accident, it was discovered to have arisen from the breaking of one of the chains, by which the iron pillars supporting the bridge are stayed and supported; and which chains, as our readers are no doubt aware, are carried to some distance on each side of the river, and secured to a great mass of masonry sunk into the ground. By the breaking of this chain, the pillar was of course deprived of its support, and the weight of the bridge immediately drew it from its situation, as we have already described. It remains then to ascertain the causes of the failure of the chain. There is no doubt that the immediate cause was the powerful vibration communicated to the bridge by the measured and uniform step of the soldiers. If the same, or a much larger number of persons had passed over in a crowd, and without observing any regular step, in all probability the accident would not have happened, because the tread of one person would have counteracted the vibration arising from that of another. But the soldiers all stepping at the same time, and at regular intervals, communicated, as we mentioned in describing the accident, a powerful vibration to the bridge, which went on increasing with every successive step; and which, causing the weight of the bridge to act with successive jerks on the stay-chains, had a more powerful effect upon them than a dead weight of much larger amount would have had, and at length broke one of the cross bolts by which the links of the chain are joined together. Perhaps this accident, alarming and injurious as it has been, may have the effect of preventing some more dreadful catastrophe in other quarters. From what has happened on this occasion, we should greatly doubt the stability of the great Menai bridge (admirable as its construction is), if a thousand men were to be marched across it in close column, and keeping regular step. From its great length, the vibrations would be tremendous before the head of the column had reached the further side, and some terrific calamity would be very likely to happen. If any considerable number of troops should be marched across that bridge (which, from its being one of the principal routes to Ireland, is not improbable), we hope the commanding officer will take the precaution of dismissing his men from their ranks before they attempt to cross: indeed, that precaution should be observed by troops crossing all chain bridges, however small they may be*." But

* The following remarks on this part of the subject are given in the Manchester Chronicle:—"It has been stated by some scientific men, and we fully concur in the opinion, that the peculiar manner in which the soldiers

But although the immediate cause of this accident was, the vibration arising from the measured step of the soldiers, it is not at all probable that so small a number as were present on the occasion would have brought down the bridge, unless there had been errors of the most glaring description committed in its construction, as well as something very faulty in a part at least of the materials of which it was composed.

The principal error of construction, and the only one to which we feel it necessary to call the particular attention of our readers, will be tolerably well understood by a reference to the subjoined engravings, and the explanation which accompanies them. The following sketch represents the manner in which the links of the chain are generally joined together.

The main links of which the chains are composed (A, A) (each of which consists of two round bars of iron, two inches in diameter, and about five feet long, but represented in the sketch as broken off near their extremities) are joined together by means of three short links and two bolts, in a manner which will be much better understood by a reference to the sketch, than by any verbal description which we could give.

A  A

This is obviously a very good and strong joint; for the bolts, being held both in the middle and at each end by the short links, would resist an enormous tension on the main links, and could not easily give way unless they were in a manner shorn asunder. This excellent mode of joining the links, however, appears to have been strangely departed from, and one of a very inferior description adopted, precisely where the strain was the greatest, and where the greatest strength ought to have been employed, namely, in each of the stay-chains or land-chains by which the whole weight of the bridge is supported. Those chains, as we

soldiers marched whilst on the bridge had no slight share in causing the accident. Before they reached the bridge we are told that they were walking 'at ease,' but when they heard the sound of their own footsteps upon it, one or two of them involuntarily began to whistle a martial tune, and they all at once, as if under a command from their officer, commenced a simultaneous military step. This uniform motion naturally gave great agitation to the bridge, the violent effects of which would be most severely felt at each end. As a familiar illustration of our meaning, we may remark, that if a rope, the ends of which being fastened to opposite walls, should be much agitated in the centre, its motion would be far more violent at the ends than in any other part.

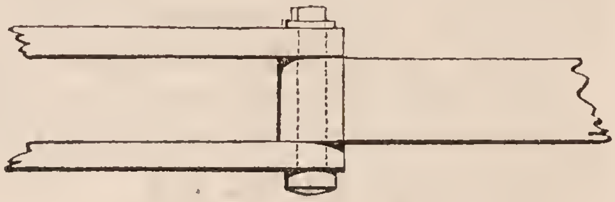
"It will not be irrelevant here to state that the rifle party, when they passed over the bridge in the morning, walked across it in an easy manner, without using the military march; that several waggons traversed it the same morning; and that the Royal Artillery, under the command of Major Chester, whilst stationed in this town, regularly crossed it with horses, guns, &c., when on their way to and from Kersall Moor."

 have

have already mentioned, are fastened to large masses of masonry beneath the surface of the ground, and this fastening is made, in each case, by means of a large disk of cast-iron, to which the first link of the chain is bolted. That link, instead of being composed like the others of two round bars of iron, and joined to the next link in the manner above described, is composed of a strap of iron, about $3\frac{1}{2}$ inches broad, and is joined to the second link by a bolt in the manner represented in the subjoined sketch.

Now it must be very obvious to any person who has the slightest acquaintance with matters of this kind, that the bolt in this link, not being supported at the ends as in the one above mentioned, could not offer a resistance nearly equal to the former, unless its dimensions were increased. But the bolt used in each case was of the same dimensions, namely, two inches in diameter. The weakness of the latter joint was also greatly increased by a circumstance, which is not very well represented in the engraving, but which we can probably explain to our readers. The bars forming the link A being round, only a very small portion of their surface touched the bolt; and as they were two inches in diameter, the point of contact was an inch distant from the side of the iron strap to which they were joined by the bolt. The tension of the chain therefore might be considered as acting on the bolt with a leverage of an inch; and, under those circumstances it was not at all surprising that the bolt should give way. Indeed it is probable that, even if it had been iron of a fair average quality, the joint would not have borne more than one-fourth, or perhaps one-fifth of the tension which the other joints would bear.

A



But the bolt, instead of being good metal, was composed of iron which was either originally bad, or had been rendered brittle by mismanagement in the process of forging the bolt. It broke with a granular and crystalline fracture, exactly like that of cast-iron, and did not exhibit anything of the fibrous appearance of good iron. Under these circumstances, the wonder is, not that the bridge should have given way now, but that it should have stood a single week after its erection.

We understand it is intended to remedy the defect to which we have alluded, not only in the chain which has given way, but in all the other stay-chains, in which it equally exists; and there can be then no doubt that the bridge will be of abundant strength to bear any load which is likely to pass over it.

A defect occurred a long time ago in the disk or plate with which the bolt was connected, and the necessary repairs were lately made under the superintendence of Mr. Stephenson, a gentleman possessing extensive knowledge in mechanics, and who resides on Mr. Fitzgerald's estate. It is due to him to state that the plate and bolt have been minutely examined, and the fact has been clearly established

blished that the accident was caused solely by the fracture in the bolt, the plate being as sound and firm as on the day on which it was attached to the masonry.

Before closing this article, we may observe that some very excellent papers on chain bridges (one of them on this particular structure) have been read at the Literary and Philosophical Society in this town, by Mr. Eaton Hodgkinson, and, we understand, are likely to appear in the forthcoming volume of the Transactions of that Society. In the paper on the Broughton bridge, some defects in its construction were pointed out, and particularly the insufficient strength of the stay-chains, as compared with that of the suspension-chains; but the particular defect which principally led to the failure of the bridge, having been concealed under ground, was not seen by the author of the paper, and of course was not mentioned in it. In an appendix to this paper, Mr. Hodgkinson strongly enforces the necessity of proving by a very high test, the chains used in the construction of bridges of this kind; and he details a variety of experiments for the purpose of showing that a test of this kind does not, as is generally supposed, diminish the strength of the metal in any sensible degree. The accident which has just occurred will go far to bear out this suggestion. If the different parts of the Broughton bridge had been carefully and adequately proved before its erection, no such joint as that which gave way could ever have existed in it.

It has been suggested to us by a friend, that great advantage would probably result if a system of periodical inspection of suspension bridges by eminent engineers were adopted by the proprietors of the bridges. In order to render the plan effectual, it would be requisite that the results of the periodical examination of every part of each bridge on which its stability depends, should be published, on the authority of the engineer employed, and for the correctness of which he should be considered responsible. By this means the attention of all parties concerned, to the most important points of construction in chain bridges would be kept alive; accidents arising from defective materials, or accumulated strains upon them, would be anticipated, and great security attained by the constant responsibility of the inspectors.

UNIVERSITY OF CAMBRIDGE.

At a congregation on Wednesday, March 9, a grace to the following effect unanimously passed the Senate:—

"To petition the King that, if it should be His Majesty's pleasure to comply with the prayer of a petition lately presented to His Majesty for a charter to incorporate under the title of 'the University of London,' the proprietors of an institution recently founded there for the general advancement of literature and science, a clause may be inserted, declaring that nothing in the terms of the charter is to be construed as giving a right to confer any academical distinctions designated by the same titles or accompanied with the same privileges, as the degrees now conferred by the Universities of Oxford and Cambridge."

MANGA-

MANGANESE IN HUMAN BLOOD.

Professor Wurzer, in analysing human blood according to Engelhart's process by liquid tests, was led to suspect that he obtained a small quantity of manganese: not being however quite satisfied as to the correctness of his analyses, he was induced to repeat them in the following manner. The blood, which had been obtained by venesection, on the day before the experiment, was ignited in an open crucible, the incinerated mass oxidized by nitre, and then diluted with water; the residuum was dissolved in muriatic acid, and the iron precipitated from the solution by succinate of ammonia. As the precipitate contained also some phosphate of lime, it was again ignited, and then dissolved in muriatic acid; the phosphate of lime was separated from the solution by alcohol, the excess of the latter expelled by heat, and the iron precipitated by ammonia. By boiling the filtered liquid with carbonate of soda, the manganese was precipitated, and then dissolved in nitric acid and again ignited. In two grammes of the incinerated residue there were found 0·108 of oxide of iron, and 0·034 of protoxide of manganese.—*Poggendorff's Annals.*

ON SULFO-SINAPISINE, ORIGINALLY TERMED SULFO-SINAPIC ACID.

MM. Henry, jun. and Garot have re-examined a peculiar matter found in the seed of the *Sinapis alba*, and which they some time since considered as an acid; they have now arrived at the following conclusions, viz.

That there exists in white mustard-seed a peculiar crystallizeable substance (sulfo-sinapisine), constituted of the elements of sulfo-cyanogen, and an organic matter which develops the volatile oil of mustard. It does not, however, contain any sulpho-cyanuret of calcium, as has been stated by M. Pelouze, and the sulpho-cyanic acid which he obtained was derived from the action of acids upon the mustard-seed.

The properties of sulfo-sinapisine are, that it is white and inodorous, its taste is bitter, resembling that of mustard; it is very light, compared with its bulk, more soluble in hot alcohol or water than when they are cold; the solution is always yellowish, though the substance may be perfectly colourless.

On cooling, crystals, resembling a cauliflower in appearance, are obtained; sometimes they are in the form of pearly needles, or prismatic and stellular. It crystallizes quite well in acidulated water, without altering its properties. When heated it first gives out a yellow liquid, and then decomposes into very fœtid compounds, containing carbonate and hydrosulphuret of ammonia, brown oil, and a bulky charcoal. No traces of lime, soda, or potash are discoverable.

Test papers are not altered by a solution of sulfo-sinapisine. Nitric acid speedily acts upon this substance; a bright colour, red vapours, and sulphuric acid are produced. Muriatic acid dissolves and renders it green, and when heated, a strong smell of prussic acid is observed; when sulphuric or phosphoric acid is added to this substance

stance mixed with water, and distilled, much sulpho-cyanic acid is produced, and with the former acid sulphuretted hydrogen is also evolved; the volatile product reddened blue paper strongly, and gave an intense crimson tint with permuriate of iron; carefully saturated with potash, it gave a coloured salt, but which possessed the properties of a sulpho-cyanuret. The alkalies produce singular phænomena with sulfo-sinapisine; ammonia dissolves it and renders it either yellow or orange-yellow; by evaporation small brilliant crystals are produced, which are sometimes red; they contain no alkali, and appear to consist of the substance scarcely altered: in time, the ammoniacal mixture becomes green.

A solution of potash or soda renders the colour yellow, which changes to orange and green; the solution evaporated to dryness, gives out an abundant odour of the volatile oil of mustard. When the residue is calcined it fuses, especially with potash, as the sulphocyanuret of this base does; the remainder is charcoal mixed with several salts, such as sulphates and sulphurets.

The organic substance decomposed the sulphocyanurets which were formed; for when the mass was not calcined, but dissolved, accurately saturated with sulphuric acid, evaporated to dryness and treated with alcohol, crystals were obtained by evaporation, which though not well defined possessed all the principal characters of the sulphocyanurets; namely, those of strongly reddening the persalts of iron, and of forming a white precipitate in the persalts of copper, when influenced by a deoxidizing body.

The action of salts upon the aqueous solution of sulfosinapisine is various;—the salts of lime, zinc, manganese, the acetate and subacetate of lead, produce no effect; the persalts of iron redden it strongly; persulphate of copper, the protonitrate of mercury and nitrate of silver all give white precipitates. Sulfosinapisine yielded by analysis

Carbon	50·504
Hydrogen	7·795
Azote	4·940
Sulphur	9·657
Oxygen	27·104
	100·000

Journal de Pharmacie, Jan. 1831.

EMISSION OF LIGHT DURING THE COMPRESSION OF GASES.

An evolution of light has been observed when certain gases have been compressed suddenly. M. Soissy stated, in opposition to what had been previously asserted, that it happens only with atmospheric air, and with oxygen and chlorine. M. Thenard has however found that when the pistons are moistened only with water instead of grease, no light was evolved; these trials were made on the supposition that water or muriatic acid might be formed by action upon the fatty matter.

Various substances were then subjected to compressed oxygen and

and chlorine gases, &c.; and M. Thenard has stated the following as the results of his experiments: No gas, by itself, is rendered luminous by pressure exerted in pistons in the usual manner; pressure by hand cannot raise the temperature of a gas in a glass tube much above 400° Faht.; powders which remain undecomposed at this temperature explode instantly in azote, hydrogen, or carbonic acid gas, when compressed suddenly; wood and paper suddenly compressed in oxygen inflame, and oiled paper in chlorine.—*Ann. de Chimie*, xliv. 181.

ACTION OF CHLORIDE OF BROMINE UPON WATER AND ÆTHER.

M. Sérullas has found, that chloride of bromine, though perfectly saturated with chlorine, does not decompose water; the formation of muriatic acid, which occurs when it is agitated with æther, results from the action of the chlorine upon the æther, and the same action produces bromide of carbon.

When chloride of bromine is agitated with æther and water, the chlorine may be entirely separated in the form of muriatic acid, before the bromine, which is isolated at the same time in the æther, is converted into bromic acid and bromide of carbon; the alkaline chlorides and bromides, even in very small quantity, mixed with oxide of manganese, slightly diluted sulphuric acid, and heated in a proper apparatus, give a chloride of bromine, which is collected and treated as above with æther, to separate its elements; by this method the co-existence of chlorine and bromine may be determined, how much soever either of them may predominate in a saline mixture; taking care, when the chlorine is in excess, to calcine the product of the saturation of the aqueous part, to reduce the chlorate formed to the state of chloride, that all the chlorine may be precipitated by a solution of nitrate of silver.

By means of a spirituous solution of quina or cinchonia, either free or combined, the instant that an aqueous and concentrated solution of solid chloride of iodine is sufficiently dilute to decompose water, it may be discovered; the acidulous iodate, which is precipitated in this case, and which is not produced when it is concentrated, serves as an indication.—*Ibid.* xlv. 202.

CRYSTALLIZATION OF BISMUTH.

The following process is given by M. Quesneville, jun. for producing fine crystals of bismuth:—Fuse the metal in a crucible, adding portions of nitre occasionally, and raising the heat so as to decompose the nitre, and mix the whole well by stirring; when the operation has been continued for some hours the metal assumes green and yellow colours, which remain even after it has cooled: if the metal presents only rose, violet or indigo colours, and becomes colourless when cold, good crystals will not be procured. When the metal has acquired the proper colours, it is to be poured into a hot ladle, and the surface should be prevented from cooling faster than the bottom, by being covered, or having a hot iron held near it. The cooling should be rather sudden, or otherwise the metal crystallizes in layers: when a crust has formed at the surface, a hole should be made

made through it by means of a hot coal, and not by percussion, which would disturb the crystals; the liquid metal is then to be poured out: in about half an hour the remainder of the crust may be broken, and the crystals will be found in great perfection.—*Journal de Pharmacie*, 1830, *p.* 534.

REACTION OF PERSALTS OF IRON AND CARBONATES.

M. Sorbeiran finds that the persalts of iron decomposed by neutral carbonates yield a carbonate of peroxide equally neutral: this carbonate is soon destroyed to produce a double salt, formed by the neutral alkaline sulphate and the subsulphate of iron, yielding a new sulphate of iron, before unknown, and containing three times as much base as the neutral salt: a weak alkali in excess precipitates another subsalt, which has not been before noticed, but is a true double salt, composed of the subsulphate of iron and the hydrated peroxide. The aperient saffron of Mars is a hydrate of the peroxide of iron, containing 3 atoms of water mixed with variable and accidental quantities of sesquicarbonate of iron, and sometimes neutral carbonate of iron.—*Ibid.* 1830, p. 535.

INFLAMMATION OF PHOSPHORUS BY CHARCOAL.

Dr. Bache of Philadelphia states, that, at the temperature of 60° Fahr. or upwards, carbon in the form of animal charcoal or lampblack causes the inflammation of a stick of phosphorus powdered with it: the effect takes place either in the open air, or in a close receiver of a moderate size.—*Silliman's Journal*, xviii. 373.

OBSERVATIONS ON AURORÆ BOREALES WITNESSED AT BEDFORD, AT VARIOUS TIMES, FROM APRIL 19, 1830, TO JANUARY 11, 1831. BY W. H. WHITE, H.M.C.S.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

The frequent appearance of the auroræ boreales at Bedford, lat. 52° 8′ 48″ north, long. 2′ 49″ east, may perhaps form some apology for my troubling you with a short account of them. The first that I observed was on the 19th of April, 1830. Soon after sunset a bright light appeared in the horizon about the magnetic north, which increased in brightness as the twilight decreased. I watched it till a little after nine P.M., before any coruscations could be distinguished, when a few faint flame-coloured flashes darted about 12° or 14° above the horizon about the north-west. About eleven P.M. several columns of light rose in the north-west in quick succession, which continued for upwards of an hour; some of them extended as far as the north, and were slightly tinged with red. During the appearance of the aurora up to midnight, several bright meteors appeared above it, but none of them were visible more than two seconds.

Sept. 7th.—A little before the moon rose I observed an aurora which extended from the north nearly to the north-west, from which emanated several columns of light; the rising moon soon overpowered its light, so that I could not distinguish any other coruscations.

Sept.

Sept. 8th.—The aurora again appeared, more extended than on the preceding evening. I watched it for upwards of half an hour, when clouds intervened and prevented further observation.

Sept. 17th.—The aurora borealis again appeared, soon after eight P.M., in the horizon between the north-west and north-by-east, from which emanated seven or eight reddish columns of light, two of which reached the star Benetrasch in Ursa major. Soon after nine P.M. the aurora disappeared.

Oct. 5.—At a quarter past seven P.M. an aurora again appeared between the north and north-west. A few very thin columns of light emanated. About eight P.M. a few coruscations were visible, but the rising of the moon overpowered them in light.

Oct. 16.—About half-past nine P.M. the aurora again appeared about the magnetic north, from which several columns of light, slightly tinged with red, emanated, and attained the altitude of about 40°. In one hour no traces of the aurora were visible.

Oct. 17.—An aurora again appeared and bore a strong resemblance to a morning twilight; no coruscations were visible, and it soon disappeared.

Nov. 1.—A little before nine P.M. a bright aurora was visible between the north and west points of the horizon; soon after nine, notwithstanding the moon shone very brightly, several columns of light darted up near the magnetic north, some of which attained the height of 20°. Clouds intervened about half-past nine, and the aurora was no longer visible.

Nov. 4.—An aurora appeared soon after seven P.M., which extended from the north nearly to the west. About eight a few columns of light were perceptible. The rising of the moon prevented any further observation, and the aurora soon disappeared. Two very bright meteors appeared soon after eight.

Nov. 7.—A faint aurora was visible for more than two hours, but no coruscations were distinguished. One bright meteor appeared about half-past seven.

Dec. 11.—At seven P.M. a very bright aurora borealis appeared between the north-west and north-by-east points of the horizon; at eight, clouds intervened, but at nine the sky again became clear, and very large columns of red light were seen to rise quite to the zenith; it increased in splendour till past midnight. Some of the columns appeared as if tinged with black, and had the resemblance of dense columns of smoke. Two persons who were guarding their master's property against the attacks of incendiaries, assured me that the red columns continued to play in every direction, and on every point of the compass between the east and west, till past four A.M. A respectable gentleman in this neighbourhood, who has been an attentive observer of meteorological appearances for upwards of forty years, assured me, that he never recollected during that period the Northern Lights so powerful in this country, nor did he ever observe so many meteors in any one night in his life-time; the number he could not ascertain, but he thought nearly twenty.

Dec. 12.—The aurora again appeared at six P.M. between the north-

north-east and north-west, but few coruscations were visible till about ten P.M., when several columns of white light darted in quick succession up to the zenith. Huge masses of white light, if I may so term them, rose in the north-west, and, as it were, sailed majestically along the horizon to the true north, and some as far as north-east, and then shot up in massy columns. These appearances lasted till half-past eleven, when the aurora began to diminish in brightness, and in about two hours disappeared. Two bright meteors appeared in the north.

Dec. 13.—The aurora again appeared light in strong twilight, but no coruscations were visible.

Dec. 14.—At six P.M. the aurora was again visible, but fainter than on the preceding evening.

Jan. 7, 1831.—An aurora borealis appeared in the north-east, which had a reddish tinge, and had a similar effect to the rising moon on a hazy evening. At a quarter past five a zone of white light rose from the centre of the aurora, passed over the Pleiades just below Aries, and to the west-south-west point of the horizon, forming a complete arc. After remaining in a perfect state for about three minutes, the centre of the bow began to disappear, and in a few seconds the whole vanished. Several patches of white light were afterwards formed in the south-east and south-west, which remained for some time. At twenty minutes past five, perpendicular columns of red and white light darted up to the zenith, and some even passed the zenith and reached Orion, having an altitude of about 30° south. At half-past five the northern hemisphere appeared to be covered with a complete canopy of various coloured lights, which extended from north-east to west, and exhibited one of the most magnificent appearances ever witnessed in this latitude. Columns of light continued to emanate till past midnight. The aurora did not finally disappear till about four A.M.

Jan. 8.—An aurora was again visible for about two hours, but no coruscations were visible.

Jan. 11.—Was a very cloudy evening, but having occasion to go out about ten o'clock, the northern parts of the heavens appeared unusually light; the clouds dispersed, and an aurora presented itself extending from north to north-west; two or three coruscations were visible, but clouds again intervened, and at eleven the aurora could no longer be seen.

N.B. After the auroræ in November and December, we had strong gales of wind from the south and south-west; but since the appearances of the present year we have had a calm.

Should these notices, copied from my journal, merit a place in your Magazine, your insertion of them may cause naturalists in different parts of the country to make some useful remarks upon them.

I have the honour to be, Gentlemen,

Your most obedient Servant,

W. H. White, H.M.C.S.

Bedford,
January 12th, 1831.

REV. W. D. CONYBEARE'S PRELIMINARY ADDRESSES TO THE COURSE OF LECTURES ON THEOLOGY, DELIVERED AT THE COLLEGIATE INSTITUTION OF BRISTOL.

A Collegiate Institution for the diffusion of the superior branches of Education has been recently established at Bristol, by the joint subscriptions of a proprietary body: it has been placed under the superintendence of a Principal and Vice-Principal, who are distinguished graduates from the University of Cambridge. As it was desired to place the Institution on an extensively useful and liberal basis, impartial admission to the advantages it offers is conceded without distinction to the members of different religious communities: at the same time a large portion of the Council (being members of the Established Church) have felt it their duty in no manner to neglect the providing due means for the religious instruction of the pupils, belonging to the same persuasion, in the tenets of that Church. They have accordingly formed themselves into a special committee, for the purpose of arranging an appropriate course of Theological Lectures. The Rev. W. D. Conybeare, who is Visitor of the College and Superintendant of its Examinations, has undertaken the commencing course of these lectures, and recently delivered three preliminary addresses, which are now in the press, and will shortly be published by Mr. Murray. The subjects are:—

I. On the proper application of classical and scientific education to the purposes of theological instruction.

II. On the natural evidences of religion as deduced from the several branches of science.

III. On the argument from analogy, and on the peculiar evidences and doctrinal character of the Christian revelation.

As Editors of a Philosophical Journal, our concern is of course principally with the Second Part. In this we understand the author has endeavoured to exhibit a compendious and condensed view of the arguments derived from the proofs of design in the physical organization of the universe, following the steps of Ray, Derham, and Paley, but with a special view to point out the additional illustrations deduced from the more recent discoveries of science. As delivered to a collegiate body, one of the objects of which must naturally be considered as directed to scientific instruction, it has been the aim of the author of this address so to treat his subject as to present its inferences as applications arising from the facts developed in the several sciences exhibited in a systematic arrangement. Thus the heads of his subdivisions are Dynamics; the Cosmical sciences; Astronomy, and Geology: those relating to the constituent principles of Nature, Light, Heat, Electricity, Chemistry; and Animal and Vegetable Physiology, including under the former an article on Entomology.

DR. WEBSTER'S DICTIONARY.

The Proprietors of the Edition of Dr. Webster's English Dictionary publishing in this country, have purchased from the family of the late Rev. Jonathan Boucher, Vicar of Epsom, the valuable and voluminous MSS. which he had, during the last fourteen years of

of his life, prepared for a Glossary of Provincial and Archæological Words, intended as a Supplement to Dr. Johnson's Dictionary; and they mean to publish these MSS. in one volume 4to, containing Six Numbers of twenty sheets each, as a Supplement to Dr. Webster's English Dictionary. The larger portion of the MSS. is now in a state fit for publication; and the Supplement will be commenced as soon as the work of Dr. Webster, of which Eight Numbers have already appeared, is completed. They also intend to publish an octavo edition of Dr. Webster's English Dictionary, which will contain all the technical and scientific definitions from the quarto work; but without the copious etymological matter, which will not be required by ordinary readers, for ordinary purposes. A multitude of words, collected by the Editor, and not found in the quarto edition, will be inserted, and also a large collection of Archaic terms from the MSS. of the late Rev. Jonathan Boucher.

LUNAR RAINBOWS.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

An hour after moonrise on the showery night of the 31st ult., I observed an entire lunar rainbow, of a whitish hue, the prismatic colours not being clearly distinguishable. The moon was then shining beautifully bright from beneath the dark brow of an overhanging cloud; but her light was above one-fourth part less than at her full, four complete days having nearly elapsed since her opposition.

Since witnessing the above I have made numerous inquiries both in this neighbourhood and in Penzance, to ascertain whether lunar rainbows are of frequent or of rare occurrence in Cornwall; and the result of these inquiries is, that there is scarcely an individual in the habit of being out late at night in this rainy county who has not repeatedly seen them. I mention this, as all the writers on meteorology which I have read, consider these phænomena of much rarer occurrence than in reality they are.

I am, Gentlemen, your very humble Servant,

Redruth, Feb. 28, 1831. RD. EDMONDS.

LUNAR OCCULTATIONS.

Occultations of Planets and fixed Stars by the Moon, in May 1831. *Computed for Greenwich, by* THOMAS HENDERSON, *Esq.; and circulated by the Astronomical Society.*

1831.	Stars' Names.	Magnitude.	Ast. Soc. Cat. No.	Immersions.				Emersions.			
				Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.	Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.
				h m	h m	°	°	h m	h m	°	°
May 21	γ Virginis*	4	1465 / 1466	13 27	9 32	122	132	14 9	10 13	186	203
22	l^2 Virginis	6	1545	16 31	12 31	37	66	17 30	13 31	281	315

* Double star.

METEOROLOGICAL OBSERVATIONS FOR MARCH 1831.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·443. Mar. 31. Wind N.E.—Min. 29·213. Mar. 6. Wind W.
Range of the mercury 1·230.
Mean barometrical pressure for the month .... 29·906
Spaces described by the rising and falling of the mercury............ 7·943
Greatest variation in 24 hours 0·605.—Number of changes 16.
Therm. Max. 58°. March 27. Wind S.—Min. 32°. March 23. Wind E.
Range 26°.—Mean temp. of exter. air 46°·98. For 30 days with ☉ in ♓ 46·56
Max. var. in 24 hours 18°·00.—Mean temp. of spring-water at 8 A.M. 48·84

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the evening of the 2nd .... 96°
Greatest dryness of the atmosphere, in the afternoon of the 19th... 51
Range of the index 45
Mean at 2 P.M. 67°·0.—Mean at 8 A.M. 75°·6.—Mean at 8 P.M. 77·2
—— of three observations each day at 8, 2, and 8 o'clock .... 73·3
Evaporation for the month 2·40 inches.
Rain in the pluviameter near the ground 1·770 inch.
Prevailing wind, West.

Summary of the Weather.

A clear sky, 4½; fine, with various modifications of clouds, 11; an overcast sky without rain, 10; rain, 5½.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
15	6	25	1	17	18	18

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1½	4½	3½	2	4½	5	6½	3½	31

General Observations.—The first part of this month was wet and windy; the latter part was dry, with great changes in the temperature of the atmosphere, and frequent strong equinoctial gales, which on several occasions were blighty. The general mildness of the weather the last two months, has made the spring nearly a fortnight earlier than that of last year. From the 2nd to the 16th instant a quick budding and leafing of the trees were observed; but the cold northerly and easterly gales nearly suspended these operations of nature during the latter part of the month. In the mornings of the 10th, 18th, 19th, 20th, 23rd, 24th, 25th, and 28th, hoar frost appeared in the grass fields before sunrise, and there was some ice on the ground in the morning of the 24th.

In the evenings of the 13th and 14th the inosculation of passing *nimbi* produced lightning and thunder. In the morning of the 24th from 8 till 12 o'clock, there were frequent falls of snow, sleet and hail.

The atmospheric and meteoric phænomena that have come within our observations this month, are four meteors, four auroræ boreales, lightning on two evenings and thunder on one; and seventeen gales of wind, or days on which they have prevailed, namely, three from the North-east, three from the East, two from the South, five from the South-west, and four from the West.

Lunar Eclipse.—On the 26th the moon rose about East by North, very nearly half eclipsed, at $5^h\ 28^m$ P.M. mean time here; but the red haze in and several degrees above the eastern horizon, prevented the earth's shadow from being well defined on her disc.

The

The eclipse continued interesting till one minute after six, when clouds intervened, and it was not seen afterwards by the naked eye. But at twenty minutes past six, mean time, there was an opening in the cloud, when by the aid of a telescope it appeared that the moon's southern limb had just emerged out of the earth's shadow, as the penumbra was then separating from the moon's limb.

Auroræ Boreales.—In the evening of the 7th of March 1831, an aurora borealis appeared from seven till ten o'clock. It rose slowly the first half-hour, and the arch of light, extending from the North-east by North to North-west by West, attained its greatest altitude about half-past eight. Soon after eight two columns of light emanated from the aurora about sixty degrees West of North, and were followed by many others till nine. At a quarter before nine several broad flame-coloured columns rose through Cassiopeia, and suddenly changed to red and lake colours; and on receding, parts of them were left behind, which continued several minutes in the form of red patches.

The mean of several altitudes of the upper edge of the arch of the aurora when best defined (not a rainbow-like arch) between 8 and 9 o'clock, taking the vertex to be in the magnetic north, was 10° 3′. At nine the aurora began to sink, and disappeared by ten.

In the night of the 8th, when the clouds disappeared at 11 o'clock, a faint aurora presented itself, and kept up till 1 A.M.

In the evening of the 11th, at half-past eight, an aurora borealis rose slowly from the northern horizon, and at forty minutes past nine its arch of light was brightest and at its greatest altitude, which was nearly the same as that in the evening of the 7th, described above.

At ten minutes before ten there was a range of twelve flame-coloured columns along the whole extent of the arch, about seven degrees distant from each other, one degree wide, and twenty-five degrees in altitude, which had a fine and rather a singular appearance. A few drops of rain now fell from a distant *nimbus* towards the North, which soon passed off to the eastward, and the aurora appeared again, but sunk slowly, with occasional coruscations from it till twelve, when it disappeared.

REMARKS.

London.—March 1. Fine. 2, 3. Rain. 4. Slight fog in the morning: very fine. 5. Overcast. 6. Stormy and wet. 7. Fine. 8. Overcast: rain at night. 9. Fine. 10. Foggy. 11. Rain. 12. Fine in the morning: windy, with rain at night. 13. Stormy and wet. 14. Fine: showery: fine at night. 15. Stormy and wet. 16. Cloudy: small rain: fine. 17—20. Fine. 21—23. Cold and dry. 24. Sleet: cold rain, with some hail in the afternoon. 25. Windy, and cold: rain at night. 26. Wet in the morning: fine. 27. Very fine: at night windy with showers. 28. Fine. 29—31. Cold and dry, with north-east wind.

Penzance.—March 1. Fair. 2. Misty. 3. Rain. 4. Misty. 5. Rain. 6, 7. Fair. 8. Rain. 9. Fair. 10. Fair: rain. 11. Rain: fair. 12. Rain. 13, 14. Showers. 15, 16. Rain. 17—21. Clear. 22, 23. Fair. 24. Clear: rain. 25. Fair: rain. 26. Rain. 27, 28. Clear. 29. Fair. 30. Clear. 31. Fair.

Boston.—March 1. Fine. 2. Cloudy: rain early A.M. 3. Cloudy: rain at night. 4. Cloudy. 5. Rain. 6. Cloudy: rain at night. 7. Fine. 8. Fine: rain at night. 9, 10. Fine. 11. Rain and stormy. 12. Fine: rain P.M. 13. Fine: hail-storm at night. 14. Fine. 15, 16. Cloudy. 17. Fine. 18—23. Cloudy. 24. Snow. 25. Fine. 26. Rain. 27, 28. Fine. 29. Cloudy. 30. Fine: rain early A.M. 31. Fine.

Meteoro-

Meteorological Observations made by Mr. THOMPSON at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1831.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
March 1	29·977	29·906	29·90	29·90	30·011	29·960	29·44	48	36	50	40	48	42	37·5	W.	S.	W.	NW.	...	0·02	...	...	...
2	29·797	29·681	29·90	29·84	29·866	29·800	29·30	56	47	53	43	54	49	43	W.	SW.	SW.	NW.	...	·12	...	0·120	0·12
3	29·681	29·643	29·70	29·60	29·723	29·693	29·12	55	41	53	48	54	48	50	W.	SW.	SW.	calm	0·10	·22	0·470	·130	...
4	29·903	29·697	29·90	29·80	29·973	29·843	29·34	59	45	52	43	57	47	46	W.	W.	NW.	calm	...	·06	...	...	·10
5	29·840	29·417	29·68	29·50	29·818	29·541	29·30	52	48	54	46	54	48	47	S.	SW.	S.	SW.	...	...	·600	·140	·06
☾ 6	29·524	29·149	29·45	29·35	29·513	29·213	28·63	53	44	52	46	53	43	48	W.	NW.	W.	S.	·15	·04	...	·030	...
7	29·967	29·708	29·80	29·70	29·883	29·756	29·13	55	30	52	46	53	38	45	S.	NW.	NW.	W.	...	...	...	·020	·18
8	29·784	29·511	29·60	29·60	29·724	29·525	29·33	52	38	51	45	54	42	38·5	S.	SW.	SE.	calm	...	·12	·470	·210	...
9	29·776	29·611	29·65	29·60	29·736	29·631	29·11	55	31	51	41	54	36	42	SW.	W.	SW.	W.	·20	·02	...	·030	·06
10	30·007	29·842	29·80	29·80	29·991	29·965	29·43	57	37	52	42	53	46	41	W.	SW.	S.	NW.	...	·05	...	·080	...
11	29·843	29·664	29·90	29·70	29·888	29·655	29·21	52	35	51	48	53	38	48	SW.	NW.	W.	NW.	...	·04	·380	...	...
12	29·953	29·430	29·80	29·50	29·938	29·495	29·42	53	36	53	42	53	42	41	SW.	SW.	S.	NW.	·20	·04	·330	·175	·32
13	29·676	29·535	29·60	29·60	29·713	29·574	29·05	54	38	53	46	54	40	47	W.	W.	SW.	W.	...	·25	·205	·015	·06
● 14	29·773	29·719	29·80	29·70	29·796	29·761	29·14	51	33	48	44	50	42	42·5	W.	W.	W.	W.	...	·20	·085	·120	·18
15	29·812	29·521	29·80	29·68	29·833	29·590	29·29	54	46	52	43	53	48	41	SW.	W.	SW.	calm	·20	·04	·585	·190	...
16	29·874	29·669	29·90	29·78	29·896	29·726	29·10	60	52	55	46	56	50	48·5	W.	W.	W.	calm	...	·02	·100	...	...
17	30·063	29·885	30·05	29·90	30·114	29·943	29·20	61	36	55	49	56	40	56	W.	NW.	W.	W.	...	...	...	...	...
18	30·261	30·198	30·20	30·10	30·286	30·221	29·65	54	32	50	42	52	37	43	W.	NW.	NW.	NW.	·20	...	...	...	...
19	30·250	30·180	30·20	30·20	30·271	30·213	29·65	54	35	51	36	53	40	44	W.	NW.	NW.	NW.	...	...	...	...	...
☽ 20	30·138	30·091	30·10	30·10	30·163	30·091	29·60	56	45	51	36	52	44	46	SW.	SE.	W.	calm	...	...	...	...	...
21	30·195	30·113	30·10	30·05	30·145	30·096	29·56	55	43	53	40	56	45	50	E.	NE.	N.	calm	·20	...	...	...	...
22	30·366	30·285	30·12	30·10	30·311	30·221	29·83	49	37	50	42	50	35	43·5	E.	NE.	E.	calm	...	...	...	...	...
23	30·390	30·232	30·15	30·15	30·348	30·211	30·03	45	32	45	38	43	32	41	E.	NE.	E.	calm	...	...	...	...	...
24	30·009	29·785	30·00	29·70	29·952	29·771	29·73	43	34	44	32	40	35	36·5	E.	NE.	NE.	E.	·40	·05	...	·030	...
25	29·685	29·545	29·40	29·25	29·621	29·461	29·50	45	40	48	35	46	42	41	E.	SE.	E.	E.	...	·50	·210	·480	...
26	29·698	29·369	29·50	29·05	29·646	29·353	29·16	60	42	53	38	53	46	39·5	S.	SW.	S.	E.	...	·12	·150	...	...
27	30·015	29·934	29·90	29·75	30·018	29·854	29·50	65	33	54	43	58	40	48·5	W.	SE.	S.	calm	·30	...	...	...	...
○ 28	30·123	30·062	29·98	29·95	30·083	30·035	29·72	62	39	55	41	58	41	49	E.	SE.	NE.	calm	...	...	...	...	...
29	30·289	30·200	30·05	30·00	30·193	30·147	29·88	46	37	47	45	56	38	42	NE.	E.	NE.	calm	...	...	...	...	...
30	30·366	30·324	30·30	30·20	30·295	30·270	30·16	48	37	47	34	49	39	44	NE.	NE.	NE.	calm	...	...	...	...	·05
31	30·515	30·440	30·30	30·30	30·443	30·378	30·16	64	37	48	38	48	37	45	NE.	NE.	NE.	calm	·45	...	...	...	...
	30·515	29·149	30·30	29·05	30·443	29·213	29·44	65	30	55	32	58	32	44·3					2·40	1·91	3·585	1·770	1·13

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

JUNE 1831.

LIX. *On a Combination of Bicyanide of Mercury and Iodide of Potassium.* By JAMES APJOHN, *M.D. Professor of Chemistry to the Royal College of Surgeons in Ireland.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING recently, in the course of some experiments upon the salts of mercury, fallen upon a new, and, in some respects, a rather remarkable compound, I beg leave to communicate to chemists, through your Journal, the following brief notice of it.

When liquid hydriodate of potash is added to a solution of corrosive sublimate, the well-known biniodide of mercury immediately falls down. This is a decomposition familiar to every chemist. But if for corrosive sublimate we substitute the bicyanide of mercury,—notwithstanding the analogy in composition between these two salts, no such double exchange of principles takes place. A precipitate however in this case also slowly forms, possessing the following properties. It occurs in very thin four-sided prisms, of a beautiful pearly aspect. These are very soluble in hot water, but this fluid scarcely acts upon them at the temperature of 60°. Digested with ammonia and potash they appear to experience no change; and the same may be said of them when brought into contact with the alkaline carbonates. When touched however with a drop of muriatic acid, their colour is immediately changed to a bright scarlet, and the odour of prussic acid is evolved. A portion of them ignited in a platinum crucible left a residuum which, when dissolved in water, gave a copious crystalline precipitate with tartaric acid added in excess.

From these experiments, and several others which it is unnecessary

unnecessary to detail, it became obvious that the crystals were composed of the two salts presented to each other. The next object therefore, was to determine the relative proportions in which these were united. To effect this, 40 grains of the compound were dissolved in hot water, and a stream of sulphuretted hydrogen passed through the solution as long as it threw down any precipitate. This, (which by a previous experiment was known to be bisulphuret of mercury,) when perfectly dry, weighed 22·25 grains. Hence as 232 (atomic weight of cinnabar) : 252 (atomic weight of bicyanide of mercury) : : 22·25 : 24·16 = the bicyanide in the 40 grains.

The solution from which the cinnabar was thrown down was now evaporated to dryness, in order to expel the whole of the prussic acid formed; and to the residue, which by a previous trial was found to be iodide of potassium, after being dissolved in water, nitrate of silver was added as long as it caused any precipitate. This (the iodide of silver) collected upon a double filter, dried and weighed, amounted to 22·08 grains. Hence as 234 (atomic weight of iodide of silver) : 164 (atomic weight of iodide of potassium) : : 22·08 : 15·47 = the iodide of potassium in the compound. The 40 grains were therefore constituted as follows:

Bicyanide of mercury..............	24·16
Iodide of potassium................	15·47
	39·63

Now, as 24·16 : 15·47 are very nearly in the ratio of 252 : 164, it is obvious that the compound consists of an atom of each of its constituent salts. And as, by viewing these as destitute of oxygen and hydrogen, we account for the entire 40 grains, it is clear that they are present as bicyanide and iodide, not as biperprussiate and hydriodate. This latter conclusion also is confirmed by the salt yielding no water upon being heated strongly in a glass tube.

This compound, as far as my knowledge extends, is without any perfect parallel in chemistry. It is a double salt, but it is distinguished from all those with which we have been long acquainted by the circumstance of the proximate constituents of its component salts, both the electro-negative and the electro-positive, being all different. Berzelius says (*Traité de Chimie*, tom. troisième p. 331): "On ne connait pas d'exemple bien constaté de sels qui renferment plus de trois constituans." The hiatus here alluded to is obviously filled up by the salt just described, and which, from its composition, may be denominated the iodo-bicyanide of potassium and mercury.

It

It is almost unnecessary to observe, that the change of colour already noticed as being produced in our compound by the action of muriatic acid, is due to the development of hydriodic acid, which passing to the bicyanide, produces at the same time, biniodide of mercury and prussic acid. A similar effect is produced by any other acid capable of liberating hydriodic acid from the iodide of potassium. In such experiments it is clear that but one half of the mercurial salt can be converted into biniodide; for one atom of the bicyanide of mercury would require for perfect decomposition two atoms of hydriodic acid, whereas but one can be developed from the iodide of potassium.

The iodo-bicyanide of potassium and mercury is probably but one of a class of double salts which the bicyanide of mercury forms with haloid compounds. This conjecture, however, I have not as yet had time to put to the test of experiment.

Dublin, May 14, 1831.

LX. *On* Mr. Lindley's *Statement respecting the Investigation of the Structure of the* Orchideæ. *By* J. E. B.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I REGRET exceedingly to be compelled, by the high estimation I entertain for the character of Mr. Brown the botanist, to be obliged to notice, thus publicly, a statement by Mr. Lindley in his "Introduction to the Natural System of Botany," from which an inference has been drawn, by an anonymous writer in a Northern Journal, prejudicial to the reputation of that gentleman. Those who are acquainted with Mr. Brown will at once acquit him of all desire to deck himself in borrowed plumes; but as there are many persons, whose good opinion is worth preserving, and to whom he may be a stranger, I deem it but justice to state what appears upon the face of the proceeding; yet I should not have interposed, if Mr. Lindley had not contented himself with only privately disavowing his intention to convey to his readers the meaning imputed to him.

The Dedication to the "Introduction" bears the date of August last. Under the head of "*Orchideæ*," p. 262, after remarking that it is not necessary to enter upon an historical view of the gradual alteration which has taken place in the opinion of botanists with regard to the sexual apparatus of

 these

these most curious of plants, the author adds, "The errors have been corrected in a more or less perfect manner by various writers, most completely by Mr. Brown in his *Prodromus*, published in 1810, and subsequently by the late most accurate and indefatigable Richard. But long before the publication of any rational explanation of the structure of the *Orchis* tribe, while botanists were in utter darkness upon the subject, it had been most fully investigated by a gentleman, unrivalled for the perfection of his microscopical analysis, the beauty of his drawings, and the admirable skill with which he follows nature in her most secret workings; and let me add, which is a still rarer quality, the generous disinterestedness with which he communicates to his friends the result of his patient and silent labours. I have sketches before me by Mr. Bauer, executed from 1794 to 1807, in which not only all that has been published since that period is shown in the most distinct and satisfactory manner, but in which much more is represented than botanists are even now aware of. I hope to be the humble means of giving some of these extraordinary productions of the pencil to the world, in an 'Illustration of the Genera and Species of Orchideous Plants,' which is now in preparation."

Whether the inference which has been drawn from this passage, that Mr. Brown was indebted for his observations to Mr. Bauer, without acknowledgement, be legitimate, may, perhaps, be questioned. It is enough to say that it *has* been drawn; and therefore it was incumbent on Mr. Lindley, if he had so worded his statement as to leave his meaning doubtful, to take the earliest opportunity, and in the most public manner, to prevent the unfounded impression.

Mr. Brown has on every occasion been ready to claim for his friend Mr. Bauer the high merit he deserves. In the *Prodromus*, he acknowledges himself indebted to him for the true character of *Ophrys;* while in the account of the genus *Woodsia* (Linn. Trans. vol. xi.), of *Rafflesia* (Ib. vol. xiii.), and of the Plants collected in Melville Island, he has expressed his obligations in such a manner as manifests an entire willingness to do him justice. The fact of twenty years having elapsed since the publication of Mr. Brown's views, and an uninterrupted friendship having continued ever since, furnishes at least a presumption that Mr. Bauer has no ground of complaint; but, to prevent all possibility of doubt, Mr. Bauer has, in writing, wholly and entirely acquitted Mr. Brown of the charge insinuated against him.

May 6th, 1831. J. E. B.

LXI. *On*

LXI. *On the Calculation of the Orbits of Double Stars.* *By* Professor Encke.

[Continued from page 183.]

THE first condition to be fulfilled with regard to the four places, is, that they must all be in an ellipse. If we denote its two semi-axes by a and b, and the excentric anomalies, as they are called, corresponding to the four places, by E_1, E_2, E_3, E_4, and assume the axis major of the ellipse as the axis of the abscisses, and the centre of the ellipse as their point of beginning; this condition will be fulfilled, if for the abscisses and ordinates of the four points the following equations take place:

$$\begin{array}{ll} x_1 = a \cos E_1 & y_1 = b \sin E_1 \\ x_2 = a \cos E_2 & y_2 = b \sin E_2 \\ x_3 = a \cos E_3 & y_3 = b \sin E_3 \\ x_4 = a \cos E_4 & y_4 = b \sin E_4 \end{array}$$

If we designate the centre of the ellipse by I, we obtain for the double areas of the triangles:

$$(1) \qquad \begin{array}{l} (\mathrm{I}\ 1\ 2) = a\, b \sin E_2 - E_1) \\ (\mathrm{I}\ 1\ 3) = a\, b \sin E_3 - E_1) \\ (\mathrm{I}\ 1\ 4) = a\, b \sin E_4 - E_1) \\ (\mathrm{I}\ 2\ 3) = a\, b \sin E_3 - E_2) \\ (\mathrm{I}\ 2\ 4) = a\, b \sin E_4 - E_2) \\ (\mathrm{I}\ 3\ 4) = a\, b \sin E_4 - E_3) \end{array}$$

and hence for the double areas of the triangles between the places themselves,

$$\begin{array}{l} (1\ 2\ 3) = a\, b \{\sin (E_2 - E_1) + \sin (E_3 - E_2) - \sin (E_3 - E_1)\} \\ (1\ 2\ 4) = a\, b \{\sin (E_2 - E_1) + \sin (E_4 - E_2) - \sin (E_4 - E_1)\} \\ (1\ 3\ 4) = a\, b \{\sin (E_3 - E_1) + \sin (E_4 - E_3) - \sin (E_4 - E_1)\} \\ (2\ 3\ 4) = a\, b \{\sin (E_3 - E_2) + \sin (E_4 - E_3) - \sin (E_4 - E_2)\} \end{array}$$

which, by the introduction of this equation,

$$E_3 - E_1 = (E_2 - E_1) + (E_3 - E_2),$$

and the analogous ones, may be reduced to these forms:

$$(2) \qquad \begin{array}{l} (1\ 2\ 3) = 4\, a\, b \sin \tfrac{1}{2} (E_2 - E_1) \sin \tfrac{1}{2} (E_3 - E_2) \sin \tfrac{1}{2} (E_3 - E_1) \\ (1\ 2\ 4) = 4\, a\, b \sin \tfrac{1}{2} (E_2 - E_1) \sin \tfrac{1}{2} (E_4 - E_2) \sin \tfrac{1}{2} (E_4 - E_1) \\ (1\ 3\ 4) = 4\, a\, b \sin \tfrac{1}{2} (E_3 - E_1) \sin \tfrac{1}{2} (E_4 - E_3) \sin \tfrac{1}{2} (E_4 - E_1) \\ (2\ 3\ 4) = 4\, a\, b \sin \tfrac{1}{2} (E_3 - E_2) \sin \tfrac{1}{2} (E_4 - E_3) \sin \tfrac{1}{2} (E_4 - E_2) \end{array}$$

The double area of the whole quadrilateral figure will then be found after a small reduction:

$$(3) \qquad (1\ 2\ 3\ 4) = 4\, a\, b \sin \tfrac{1}{2} (E_3 - E_1) \sin \tfrac{1}{2} (E_4 - E_2) \sin \{\tfrac{1}{2} (E_4 + E_2) - \tfrac{1}{2} (E_3 + E_1)\}$$

For

For the chords we shall obtain these expressions:

$$
(4)\quad
\begin{aligned}
(1\,2)^2 &= 4 \sin\tfrac{1}{2}(E_2-E_1)^2 \left\{a^2 \sin\tfrac{1}{2}(E_2+E_1)^2 + b^2 \cos\tfrac{1}{2}(E_2+E_1)^2\right\}\\
(1\,3)^2 &= 4 \sin\tfrac{1}{2}(E_3-E_1)^2 \left\{a^2 \sin\tfrac{1}{2}(E_3+E_1)^2 + b^2 \cos\tfrac{1}{2}(E_3+E_1)^2\right\}\\
(1\,4)^2 &= 4 \sin\tfrac{1}{2}(E_4-E_1)^2 \left\{a^2 \sin\tfrac{1}{2}(E_4+E_1)^2 + b^2 \cos\tfrac{1}{2}(E_4+E_1)^2\right\}\\
(2\,3)^2 &= 4 \sin\tfrac{1}{2}(E_3-E_2)^2 \left\{a^2 \sin\tfrac{1}{2}(E_3+E_2)^2 + b^2 \cos\tfrac{1}{2}(E_3+E_2)^2\right\}\\
(2\,4)^2 &= 4 \sin\tfrac{1}{2}(E_4-E_2)^2 \left\{a^2 \sin\tfrac{1}{2}(E_4+E_2)^2 + b^2 \cos\tfrac{1}{2}(E_4+E_2)^2\right\}\\
(3\,4)^2 &= 4 \sin\tfrac{1}{2}(E_4-E_3)^2 \left\{a^2 \sin\tfrac{1}{2}(E_4+E_3)^2 + b^2 \cos\tfrac{1}{2}(E_4+E_3)^2\right\}
\end{aligned}
$$

to which many other different forms, more convenient for individual cases, may be given.

The four equations (2) being multiplied together, and the square root being taken of the product, we obtain

$$
\begin{aligned}
&\surd\,(1\,2\,3)\,(1\,2\,4)\,(1\,3\,4)\,(2\,3\,4)\\
&= 16\,a^2 b^2 \left\{\begin{matrix} \sin\tfrac{1}{2}(E_2-E_1)\,\sin\tfrac{1}{2}(E_3-E_1)\,\sin\tfrac{1}{2}(E_4-E_1)\\ \sin\tfrac{1}{2}(E_3-E_2)\,\sin\tfrac{1}{2}(E_4-E_2)\,\sin\tfrac{1}{2}(E_4-E_3)\end{matrix}\right\}
\end{aligned}
$$

an equation in which all six combinations of the equations occur. The product of any two of the equations (2) gives only five combinations

$$
\begin{aligned}
(1\,2\,3)\,(1\,3\,4) &= 16\,a^2 b^2 \left\{\begin{matrix} \sin\tfrac{1}{2}(E_2-E_1)\ \sin\tfrac{1}{2}(E_3-E_1)^2\ \sin\tfrac{1}{2}(E_4-E_1)\\ \sin\tfrac{1}{2}(E_3-E_2)\ \sin\tfrac{1}{2}(E_4-E_3)\ \ldots\ldots\ldots\ldots \end{matrix}\right\}\\
(1\,2\,3)\,(1\,2\,4) &= 16\,a^2 b^2 \left\{\begin{matrix} \sin\tfrac{1}{2}(E_2-E_1)^2\ \sin\tfrac{1}{2}(E_3-E_1)\ \sin\tfrac{1}{2}(E_4-E_1)\\ \sin\tfrac{1}{2}(E_3-E_2)\ \sin\tfrac{1}{2}(E_4-E_2)\ \ldots\ldots\ldots\ldots \end{matrix}\right\}\\
(1\,2\,3)\,(2\,3\,4) &= 16\,a^2 b^2 \left\{\begin{matrix} \sin\tfrac{1}{2}(E_2-E_1)\ \sin\tfrac{1}{2}(E_3-E_1)\ \sin\tfrac{1}{2}(E_3-E_2)^2\\ \sin\tfrac{1}{2}(E_4-E_2)\ \sin\tfrac{1}{2}(E_4-E_3)\ \ldots\ldots\ldots\ldots \end{matrix}\right\}
\end{aligned}
$$

Dividing the above square root by each of these products, we obtain the following equations:

$$
(5)\quad
\begin{aligned}
\sqrt{\frac{(1\,2\,4)\,(2\,3\,4)}{(1\,2\,3)\,(1\,3\,4)}} &= \frac{\sin\tfrac{1}{2}(E_4-E_2)}{\sin\tfrac{1}{2}(E_3-E_1)}\\
\sqrt{\frac{(1\,3\,4)\,(2\,3\,4)}{(1\,2\,3)\,(1\,2\,4)}} &= \frac{\sin\tfrac{1}{2}(E_4-E_3)}{\sin\tfrac{1}{2}(E_2-E_1)}\\
\sqrt{\frac{(1\,2\,4)\,(1\,3\,4)}{(1\,2\,3)\,(2\,3\,4)}} &= \frac{\sin\tfrac{1}{2}(E_4-E_1)}{\sin\tfrac{1}{2}(E_3-E_2)}
\end{aligned}
$$

Assuming now

$$
(6)\quad
\begin{aligned}
\sqrt{\frac{(1\,2\,3)\,(1\,2\,4)}{(1\,3\,4)\,(2\,3\,4)}} &= \operatorname{tang}\zeta\\
\sqrt{\frac{(1\,2\,3)\,(1\,3\,4)}{(1\,2\,4)\,(2\,3\,4)}} &= \operatorname{tang}\zeta_1\\
\sqrt{\frac{(1\,2\,3)\,(2\,3\,4)}{(1\,2\,4)\,(1\,3\,4)}} &= \operatorname{tang}\zeta_2
\end{aligned}
$$

we have

$$
\operatorname{tang}(45^\circ + \zeta) = \frac{\operatorname{tang}\tfrac{1}{4}(E_4-E_3+E_2-E_1)}{\operatorname{tang}\tfrac{1}{4}(E_4-E_3-E_2+E_1)}
$$

tang

$$\operatorname{tang}(45^\circ + \zeta_1) = \frac{\operatorname{tang}\frac{1}{4}(E_4+E_3-E_2-E_1)}{\operatorname{tang}\frac{1}{4}(E_4-E_3-E_2+E_1)}$$

$$\operatorname{tang}(45^\circ + \zeta_2) = \frac{\operatorname{tang}\frac{1}{4}(E_4+E_3-E_2-E_1)}{\operatorname{tang}\frac{1}{4}(E_4-E_3+E_2-E_1)}$$

If we make, consequently,

$$(7)\qquad \begin{aligned} \tfrac{1}{4}(E_4+E_3+E_2+E_1) &= s \\ \tfrac{1}{4}(E_4-E_3-E_2+E_1) &= \alpha \\ \tfrac{1}{4}(E_4-E_3+E_2-E_1) &= \beta \\ \tfrac{1}{4}(E_4+E_3-E_2-E_1) &= \gamma, \end{aligned}$$ we have

$$(8)\qquad \begin{aligned} \operatorname{tang}\beta &= \operatorname{tang}(45^\circ + \zeta)\operatorname{tang}\alpha \\ \operatorname{tang}\gamma &= \operatorname{tang}(45^\circ + \zeta_1)\operatorname{tang}\alpha \\ \operatorname{tang}\gamma &= \operatorname{tang}(45^\circ + \zeta_2)\operatorname{tang}\beta \end{aligned}$$

so that, ζ, ζ_1, ζ_2 being derived from known quantities (B), if one of the quantities α, β, γ is known, the other two will be found in a very simple manner, and consequently all differences between the excentric anomalies; as we have

$$\begin{aligned} \tfrac{1}{2}(E_2-E_1) &= \beta-\alpha, & \tfrac{1}{2}(E_3-E_1) &= \gamma-\alpha, \\ \tfrac{1}{2}(E_4-E_1) &= \gamma+\beta, & \tfrac{1}{2}(E_3-E_2) &= \gamma-\beta, \\ \tfrac{1}{2}(E_4-E_2) &= \gamma+\alpha, & \tfrac{1}{2}(E_4-E_3) &= \beta+\alpha. \end{aligned}$$

The equations (7) may likewise be written in this manner:

$$(9)\qquad \begin{aligned} \sin(\beta-\alpha) &= \operatorname{tang}\zeta\ \sin(\beta+\alpha) \\ \sin(\gamma-\alpha) &= \operatorname{tang}\zeta_1 \sin(\gamma+\alpha) \\ \sin(\gamma-\beta) &= \operatorname{tang}\zeta_2 \sin(\gamma+\beta) \end{aligned}$$

Substituting the quantities $\alpha\beta\gamma$ in the expression for (1 2 3 4) in (3), we shall find,

$$(10)\qquad (1\,2\,3\,4) = 4\,a\,b\sin(\gamma-\alpha)\sin(\gamma+\alpha)\sin 2\beta.$$

Between the quantities ζ, ζ_1, ζ_2, and α, β, γ, there are different relations, which may serve to check or to change the developments. Thus we have:

$$(11)\qquad \operatorname{tang}(45^\circ+\zeta)\,.\,\operatorname{tang}(45^\circ+\zeta_2) = \operatorname{tang}(45^\circ+\zeta_1);\ \text{or}$$

$$(12)\qquad \sin 2\zeta - \sin 2\zeta_1 + \sin 2\zeta_2 = \sin 2\zeta \sin 2\zeta_1 \sin 2\zeta_2.$$

Combining these with the equations

$$\frac{2}{\cos 2\zeta} = \operatorname{cotang}(45^\circ + \zeta) + \operatorname{tang}(45^\circ + \zeta)$$

$2\operatorname{tang} 2\zeta = \operatorname{tang}(45^\circ + \zeta) - \operatorname{cotang}(45^\circ + \zeta)$, we obtain

$$\operatorname{tang} 2\zeta\operatorname{cotang}(45^\circ+\zeta_2) + \operatorname{tang} 2\zeta_2\operatorname{cotang}(45^\circ+\zeta) = \operatorname{tang} 2\zeta_1$$
$$\operatorname{tang} 2\zeta\operatorname{tang}(45^\circ+\zeta_2) + \operatorname{tang} 2\zeta_2\operatorname{tang}(45^\circ+\zeta) = \operatorname{tang} 2\zeta_1;$$

or introducing the angles α, β, γ,

$$\frac{\operatorname{tang} 2\zeta}{\operatorname{tang}\gamma} - \frac{\operatorname{tang} 2\zeta_1}{\operatorname{tang}\beta} + \frac{\operatorname{tang} 2\zeta_2}{\operatorname{tang}\alpha} = 0$$

(13) tang

$$(13)\quad \operatorname{tang} 2\zeta \operatorname{tang} \gamma - \operatorname{tang} 2\zeta_1 \operatorname{tang} \beta + \operatorname{tang} 2\zeta_2 \operatorname{tang} \alpha = 0$$

$$\frac{\operatorname{tang} 2\zeta}{\sin 2\gamma} - \frac{\operatorname{tang} 2\zeta_1}{\sin 2\beta} + \frac{\operatorname{tang} 2\zeta_2}{\sin 2\alpha} = 0$$

the third of which is the sum of the two others.

Deriving the value of $a\,b$ from (10), we shall find many transformations of the same by applying the following three equations, which will easily be found by the above-given relations. The three equations are:

$$(14)\quad \begin{aligned} \sin(\beta-\alpha)\sin(\beta+\alpha) &= \tfrac{1}{2}\operatorname{tang} 2\zeta \sin 2\alpha \sin 2\beta \\ \sin(\gamma-\alpha)\sin(\gamma+\alpha) &= \tfrac{1}{2}\operatorname{tang} 2\zeta_1 \sin 2\alpha \sin 2\gamma \\ \sin(\gamma-\beta)\sin(\gamma+\beta) &= \tfrac{1}{2}\operatorname{tang} 2\zeta_2 \sin 2\beta \sin 2\gamma \end{aligned}$$

We obtain accordingly,

$$(15)\quad \begin{aligned} a\,b &= \frac{(1\,2\,3\,4)}{4\sin(\gamma-\alpha)\sin(\gamma+\alpha)\sin 2\beta} \\ &= \frac{(1\,2\,3\,4)}{2\sin 2\alpha \sin 2\beta \sin 2\gamma} \operatorname{cotang} 2\zeta_1 \\ &= \frac{(1\,2\,3\,4)}{4\sin(\beta-\alpha)^2\sin 2\gamma} \frac{\operatorname{tang} 2\zeta \operatorname{tang}\zeta}{\operatorname{tang} 2\zeta_1} \\ &= \frac{(1\,2\,3\,4)}{4\sin(\gamma-\alpha)^2\sin 2\beta} \operatorname{tang}\zeta_1 \\ &= \frac{(1\,2\,3\,4)}{4\sin(\gamma-\beta)^2\sin 2\alpha} \frac{\operatorname{tang} 2\zeta_2 \operatorname{tang}\zeta_2}{\operatorname{tang} 2\zeta_1} \\ &= \frac{(1\,2\,3\,4)}{4\sin(\beta+\alpha)^2\sin 2\gamma} \frac{\operatorname{tang} 2\zeta \operatorname{cotang}\zeta}{\operatorname{tang} 2\zeta_1} \\ &= \frac{(1\,2\,3\,4)}{4\sin(\gamma+\alpha)^2\sin 2\beta} \operatorname{cotang}\zeta_1 \\ &= \frac{(1\,2\,3\,4)}{4\sin(\gamma+\beta)^2\sin 2\alpha} \frac{\operatorname{tang} 2\zeta_2 \operatorname{cotang}\zeta_2}{\operatorname{tang} 2\zeta_1} \end{aligned}$$

All which expressions will be applied below.

As soon as one of the quantities α, β, γ, would be known, not only the other two but likewise $a\,b$ would be known. For obtaining the knowledge of this one quantity the equations between time and place in the ellipse may be used.

If we conceive a circle to be described about the centre of the ellipse, whose radius is equal to the semiaxis major of the ellipse, and if we designate as corresponding points in the circle and the ellipse, those which have in both curves the same abscisses and corresponding ordinates, all areas of the two curves, inclosed by the radii of the corresponding points, by the chords between them, and by the arcs of the curves, will be in the ratio of the axes. The sector of the circle corresponding

corresponding to the points 1 and 2 is $= \frac{1}{2} a^2 (E_2 - E_1)$, the triangle between the radii and the chord of the circle $= \frac{1}{2} a^2 \sin (E_2 - E_1)$; consequently the elliptical segment will be $= \frac{1}{2} a b \{(E_2 - E_1) - \sin (E_2 - E_1)\}$; adding the triangle (012), we have, for the double area inclosed between ϱ_1, ϱ_2 and the elliptical arc, this expression;

$$(0\,1\,2) + \{(E_2 - E_1) - \sin (E_2 - E_1)\}\, a b.$$

This area is the projection of the elliptical area, described in the proper orbit in the time $(t_2 - t_1)$. The areal velocity being proportional to the time, the projected area will likewise be proportional to the time. Denoting therefore the double areal velocity in the projected ellipse by k, and applying the same formulæ to all other combinations of the four points, we have these equations:

$$(16)\quad \begin{aligned} k\,(t_2 - t_1) - (0\,1\,2) &= a b \{2(\beta - \alpha) - \sin 2(\beta - \alpha)\} \\ k\,(t_3 - t_1) - (0\,1\,3) &= a b \{2(\gamma - \alpha) - \sin 2(\gamma - \alpha)\} \\ k\,(t_4 - t_1) - (0\,1\,4) &= a b \{2(\gamma + \beta) - \sin 2(\gamma + \beta)\} \\ k\,(t_3 - t_2) - (0\,2\,3) &= a b \{2(\gamma - \beta) - \sin 2(\gamma - \beta)\} \\ k\,(t_4 - t_2) - (0\,2\,4) &= a b \{2(\gamma + \alpha) - \sin 2(\gamma + \alpha)\} \\ k\,(t_4 - t_3) - (0\,3\,4) &= a b \{2(\beta + \alpha) - \sin 2(\beta + \alpha)\} \end{aligned}$$

which, however, on account of the relations (2), form only three independent equations. The fourth depends on the two first, the fifth on the first and third, the sixth on the second and third, and *vice versâ*. It is likewise to be observed, that these equations suppose that in the interval no entire revolution has taken place, a condition which in the actual application of them will always be fulfilled.

In these equations the areas of the triangles, and the times are known; the quantities $a b$, α, β, γ, may all be regarded as functions of one only of the three quantities α, β, γ, and there are consequently three independent equations, and only two unknown quantities. There must therefore exist an equation of condition which must be fulfilled by the four points, if they are to belong to the same projected ellipse. But instead of deriving this equation beforehand, it appears to be more convenient to make use of its existence in the course of the calculation, in order to change agreeably to it a less accurate datum.

These equations, on account of their transcendental form, can only be resolved by trials. At first sight, one might be inclined to effect this by eliminating the quantities k and $a b$, which would lead to an equation between known quantities and three different transcendental functions of the form $2x - \sin 2x$. But this method is not advisable, inasmuch as in that case the

 quantity

quantity $a\,b$, which is easily calculated if once an hypothesis respecting one of the quantities α, β, γ has been adopted, would be considered as unknown. It would be supposed that all the four points belong exactly to the same ellipse, which is described agreeably to the Keplerian law; and as this supposition is never perfectly true, we should be obliged to begin a useless repetition without having a guide how to correct the error, if the value of $a\,b$ obtained by substitution in the three equations is not found to agree with its value derived from equations (15).

It is much better for the purpose to select those two of the equations (16) which belong to the best determined points, to assume by hypothesis one of the quantities, for instance α; with this quantity the values of β, γ and $a\,b$ are to be calculated by means of the equations (8) and (15), and the value of k is then to be deduced from each of the two equations (16). The value of α is to be changed until the values of k agree, and the quantities thus obtained are then to be substituted in the third equation. If little is wanting of the identity of the values, one may make a trifling change in the moments of time until everything agrees. Our observations will not, for a long time to come, be so accurate as not to admit of an alteration of a month, or 0·1 year. If the deviations are great, we may change for the less accurate observation either the distance, or the angle of position, which, indeed, renders necessary an entirely new calculation of ζ, ζ_1, ζ_2, and a complete repetition. The less accurate observation being, however, entirely contained in one of the equations (16), a little reflection will, in most cases, easily show the sign and the approximate value of the correction which is to be applied.

For facilitating these trials a table for the function

$$\phi(x) = 2\,x - \sin 2\,x \tag{17}$$

has been appended to this article, giving the value of the function for every ten minutes from $x = 0$ to $x = 90°$. The angle x being always equal to half the difference of two excentric anomalies, the table will immediately serve for any two observations, whose interval does not exceed half a revolution, which, as such may be selected from the equations (16), will generally not be the case. For other cases the values may be easily calculated, as

$$\varphi(x) = 2\,\pi - \phi(180 - x).$$

The table has been calculated to seven decimal places, but five only have been given, as these will always be sufficient.

[To be continued.]

LXII. *Ob-*

LXII. *On the Odour exhaled from certain Organic Remains in the Diluvium of the Arctic Circle, as confirmatory of* Dr. Buckland's *Opinion of a sudden Change of Climate at the Period of Destruction of the Animals to which they belonged; and on the Probability that one of the Fossil Bones, brought from Eschscholtz Bay, by* Captain Beechey, *belonged to a Species of* Megatherium. *By* E. W. Brayley *Jun., A.L.S., Teacher of the Physical Sciences in the Schools of Hazelwood and Bruce Castle.*

IN Dr. Buckland's very interesting and important article on the occurrence of the remains of elephants, &c., in the cliffs of frozen mud in Eschscholtz Bay, &c. which forms part of the Appendix to Capt. Beechey's Narrative of his Voyage to the Pacific and Beering's Strait, a strong odour of decomposing animal matter which is exhaled from some of the localities in which those remains are found, is noticed several times. Thus, in the notes extracted from the Journal of Mr. Collie, the surgeon to the Expedition, it is stated that "a very strong odour, like that of heated bones, was exhaled wherever the fossils abounded." In the extract from Capt. Kotzebue's account of the same spot it is observed, "We could not assign any reason for a strong smell, like that of burnt horn, which we perceived in this place." And "other observers," Dr. Buckland remarks, "have stated the same thing of the mud cliffs in Siberia, near the mouth of the Lena, which contain similar organic remains."—(Beechey's Narrative, Appendix, pp. 599, 601, 604.)

The odour emitted by burning bones and horn arises from the development of ammonia, mingled or combined with volatile animal substances, ensuing from the decomposition, by the heat, of the gelatine, &c. of the bodies subjected to it. Any decomposition of animal matter, however effected, in which ammonia was evolved in considerable proportion, would produce a similar smell; which may be attributed, in the instances before us, to one of the two following causes, or perhaps to both causes combined.

1st. The intense cold which froze into a mass the diluvium of the Polar Sea and its organic remains, would necessarily arrest the decomposition of many animal combinations in those remains, as well as reduce to a fixed form the volatilizable principles they contained. By this means, the evolution of volatile matters would be prevented, and others would be preserved, which, had the animal remains been exposed to such temperatures as now prevail either in the torrid or in the temperate zone, would have escaped in the volatile form, by the ordinary process of putrefaction. But in the summer, from June to October, as we find from Capt. Beechey's Meteorologi-

 cal

cal Journal, the temperature of the air in Eschscholtz Bay, rises to above 70° Fahrenheit, and that of the surface of the sea to above 50°, the solar radiation rising of course still higher than the air; and the cliffs, consequently, during this season, are constantly thawing. This change of temperature would liberate the volatile matters, and permit the further decomposition of the animal substances attached to or contained in the bones, so as to impregnate the local atmosphere with effluvia, which the succeeding winter would have no power to fix again; though it might confine them to the vicinity, and prevent their further production until the next summer.

2nd. Mr. Clift has shown that the bones found in the caverns of the Plymouth limestone, which have lost nearly all their animal matter, have probably been deprived of it by the clay with which they are surrounded having absorbed it. (Phil. Trans. 1823, p. 83.) The partial decomposition of the bones from Eschscholtz Bay may have been produced in this manner, and thus the clay in which they are found, may, during the summers which have passed since the deposition of the diluvium, have become impregnated with their animal matter. Or, the animal matter formerly surrounding and attached to these bones may have been absorbed by the clay in the same manner. And in either case, the animal substances being thus in a state of comparative minute division, mingled with the earthy matter forming the clay, and exposed to the high temperature of the summers, as well as, in the under-cliff, constantly to the operation of the sea-water, would be in the most favourable state for continual decomposition, thus producing the odour in question*. It may further be remarked, that the rapid alternations of temperature, during the summer months, from the

* The view taken by Mr. Clift of the manner in which the bones found in the caves of the Plymouth limestone, have been deprived of their animal matter, and the important connection which the nature of the mud in which the bones are imbedded at Eschscholtz Bay, may have with the circumstances of their original inhumation, show the utility of geologists', when collecting organic remains, being careful to collect specimens of their matrix, also, and not to leave the nature of that to be determined merely by the inadequate means of portions of it accidentally adhering to the fossils. It will be useful, in future, to notice this subject, in instructions to collectors and geological observers, in a more emphatic manner than has yet been done. Specimens of the matrices of organic remains, it would appear, should be collected, for the express purpose of serving for examination with respect to their influence on the mode of preservation of the latter.

Chemical analysis should also be resorted to on these points. Thus, the clay enveloping the Plymouth bones, if Mr. Clift's conjecture be well founded, would yield evidence of animal matter, and a similar examination of that in which the bones are imbedded, in Eschscholtz Bay, would be of considerable importance in the elucidation of the origin of the smell apparently diffused by them.

freezing

freezing point to above 70°, and the great alternation annually, from summer to winter, to which these matters are exposed, would further promote this successive decomposition, would indeed be most favourable to it. So that, upon the whole, the animal matter of the bones in this diluvium, or that of the tissues by which they were once invested, having been preserved by the cold, the circumstances under which they have existed since the production of that cold, have been such as to be most favourable to its constant though slow decomposition, and the necessary production of the peculiar odour perceived in the localities in which the bones are found.

Dr. Buckland, however, reasoning from the fact stated by Mr. Collie, that the odour in question was perceived at the base of another mud cliff, in Shallow Inlet, where there were no bones, thinks that in this case we must attribute it to some cause unconnected with the bones, and probably to gaseous exhalations from the mud itself. And, on this ground, he thinks that we may draw the same inference as to the origin of the odour in all the other cases also; "thus in Eschscholtz Bay," he observes, "where nearly all the bones were collected at the base of the cliff on the beach below high water, how can the presence of two or three bones only, lying half-way up the cliff, account for the odour which is emitted over a distance of more than a mile along this shore? How inadequate is a cause so partial to so general an effect! since, however numerous may be the animal remains that are buried in the interior of the cliff, no exhalations from them can escape through their impenetrable matrix of frozen mud; and even if that fallen portion of mud which constitutes the under-cliff be ever so abundantly loaded with fossil bones, it is scarcely possible that these should undergo such rapid decomposition as to transmit strong exhalations to the surface through so dense a substance as saturated clay; in fact, their high degree of preservation shows that no such rapid decomposition has taken place."—(Beechey's Narrat. Appen. p. 604.)

But the peculiar nature of the odour in question, its occurrence in two distant points where the same fossils are present under the same circumstances, and its absence, so far as has yet been recorded, in all other localities of the Arctic regions, forbid us, I think, to refer it to any other origin than the decomposition of some part of the animal matter of those fossils. The reasoning of Dr. Buckland, upon this point, does not appear to me to be conclusive. In Eschscholtz Bay, the presence of two or three bones only, lying half-way up the cliff, certainly will not account for the diffusion of the odour for a mile along the shore; but a portion of this effect may reasonably be attributed to bones in the situation of those which were actually collected by Mr. Collie, "at the base of the cliff on the beach below high

high water," where the action of the sea, combined with the alternations of temperature, would tend continually to their decomposition. We are not called upon to suppose that the fossils are undergoing rapid decomposition, nor that their exhalations are transmitted through dense saturated clay; but that they are, and have been for many ages, undergoing slow periodical decomposition, in mud, a portion of which is always covered by the waves, and another portion covered at high water*, therefore frequently in a semifluid state, and on that account very favourable to the extrication of gaseous matter†. The considerations already urged, to account for the production of the smell, will equally account for its diffusion along the shore; for it must arise from the fossils in the under-cliff, brought down by the degradation occasioned by the heat of the summer, in the manner explained by Capt. Beechey and Mr. Collie, and acted upon by that heat, in conjunction with the sea. And if the suggestion before made as to the probability of the diffusion of animal matter, by former absorption, among the earthy substances of the diluvium, and the mud resulting from its degradation, be adopted, the great diffusion of the odour will be still better explained, since "gaseous exhalations from the mud itself" would certainly arise from the decomposition of animal matter so diffused. As already observed, *rapid* decomposition would not be required for this effect; the successive exhalations arising from the slow decomposition proceeding for so many summers, retained near the spot by the stilling powers of the intense winter, and the comparative tranquillity of the atmosphere of the bay, would be amply sufficient for this effect.

Since, therefore, an adequate cause for this smell appears to exist in several localities, the just rules of induction seem to require, that we should rather regard its presence in other places, as indicating the existence of the same cause (*i. e.* the presence of fossils) in them, than attribute its production to unknown causes, in those places where the circumstances seem fully adequate to account for it. Although no bones were observed, either at Shallow Inlet, or near the em-

* In accordance with this, Mr. Collie states that the few specimens taken from the debris on the front of the cliff "were in a better state of preservation than those which had been alternately covered and left exposed by the flux and reflux of the tide, or imbedded in the mud and clay of the shoal."—(Beechey's Narrative, Appendix, p. 599.)

† Capt. Beechey, in relating his examination of the head of Eschscholtz Bay, when describing his approach to the cliff adjacent to the embouchure of Buckland River, in the earth of which he perceived the smell, (as will be stated in the sequel,) observes, "We landed upon a flat muddy beach, and were obliged to wade a quarter of a mile before we could reach a cliff for the purpose of having a view of the surrounding country."—(Narrative, p. 322.)

bouchure

bouchure of Buckland River, at the head of Eschscholtz Bay, in both which spots, however, the smell was perceived*, yet we shall not be justified in assuming, from the former circumstance, that no animal remains are contained in the diluvium at these points, resembling as it does, in all other characters, that of the other localities. It is far more likely that future degradation of the cliffs will expose them. In such situations many bones may exist undiscovered; the probability of which is confirmed by the history of Elephant Point. Nearly all the bones obtained both by the Russian and the English Expedition were collected here; but Mr. Collie states that at his first visit to the spot, in July 1826, he "saw no traces of fossils." Now, had Elephant Point not been visited a second time, we might have reasoned on the supposed absence of fossils in that locality, in the manner Dr. Buckland has actually done respecting the cliff in Shallow Inlet. And even supposing that no fossils should at present exist at the last-mentioned place, the mud may contain animal matter derived from them as formerly existing, and now itself suffering decomposition, and resolution into gaseous substances.

I have been thus particular in endeavouring to show how this odour might naturally have been produced from the animal matter of the bones, or of the soft parts in which they were once enveloped, and in combating Dr. Buckland's opinion of its having a different origin, unconnected with the organic remains in this diluvium, because, the fact that such an odour should exist in the places where those remains have been discovered, appears to me to furnish an important confirmation of one of the conclusions which have been deduced by Dr. Buckland, from the entire history of the organic remains in the diluvium of the Arctic Circle.

The conclusion to which I allude, is that of the sudden change of climate of that region, from warmth, to intense cold. For, that such an odour as the one described, should arise from the organic remains in the diluvium of the Arctic Circle, tends strongly to confirm the deduction of the suddenness of the transition from heat to cold, by which the catastrophe destroying the animals, and producing that diluvium, was accompanied.

* The latter of these spots, though described as one of those in which the smell was perceived, by Capt. Beechey, is not mentioned by Dr. Buckland. The circumstances under which the odour occurs here, appear to corroborate the inference that it arises, in all cases, from animal remains originally imbedded in the substance of the diluvium; for, speaking of the cliff itself, which is stated to have been similar in appearance to that at Elephant Point, from which the fossils were afterwards obtained, Captain Beechey remarks, that "*the earth*, in parts, had a disagreeable smell, similar to that which was supposed to proceed from the decayed animal substances in the cliff near Elephant Point."—(Narrative, p. 322.)

panied. It would be, indeed, the natural result of the destruction of animals by a mighty inundation, attended by a sudden change of temperature from warmth to intense cold, and the immediate burial of their remains in the detritus swept together by that inundation. Had the last change of temperature undergone by the polar regions been slow,—had it been a gradual transition, of course occupying considerable time, from their former high to their present very low temperature, the volatilizable substances of the animal remains in Eschscholtz Bay and at the mouth of the Lena, would have been dissipated by putrefaction, long before the freezing of the diluvium and its contents.

The facts of the preservation of the carcasses of the mammoth and rhinoceros, prove the region in which they were found to have been intensely cold at the time immediately succeeding their death; but the odour now diffused by the organic remains in the diluvium of Eschscholtz Bay and of the mouth of the Lena, affords collateral evidence to the same effect; and it is, indeed, the corresponding fact with respect to these remains, which we must suppose to have suffered in a greater degree than the carcasses by the violence of the inundation. "The carcass of a single elephant preserved in ice is," indeed, "decisive," as Dr. Buckland observes, "of the existence of continual and intense cold ever since the period at which it perished;" and that the last change from heat to cold was sudden, "is shown by the preservation of the carcass in ice;" but the induction is strengthened by our finding that evidence to the same effect is afforded by animal remains inhumed at the same epoch, but the state of which more nearly resembles that of the contemporaneous fossils in the temperate zone, and the parallelism of whose actual condition with that of the carcasses is not immediately obvious*.

In Dr. Buckland's description of the most perfect specimens of animal remains from Eschscholtz Bay, selected by him to be engraved in illustration of his memoir, and stated to be deposited in the British Museum, occurs a notice of a "Cervical vertebra of an unknown animal," on which the following remarks

* It is proper, in the investigation of subjects of the magnitude and complexity of that now before us, to notice every fact which can have any relation to them, whatever may be the influence of such facts upon our theoretical speculations. On this account I make the following remark.

Dr. Buckland observes (Narrative, Appendix, p. 610), that too much stress has been laid on the circumstance of the mammoth in Siberia being covered with hair; and cites several examples from among the existing animals of warm latitudes, to show, that no conclusive argument in proof that the Siberian elephant was the inhabitant of a cold climate can be drawn from that fact. But the most important fact I would submit, is not that certain animals

remarks are given: "It has been compared with all the skeletons in the collection at Paris, by Mr. Pentland, without finding any to which it can be referred: he thinks the nature of the articulation more resembles that in the sloth and ant-eaters than in any other animal; but the bone differs from them in other respects, and approaches to the character of the Pachydermata. The animal, whatever it was, seems to have differed essentially from any that now inhabit the polar regions of the northern hemisphere."—(Narrative, Appendix, p. 597.)

On perusing this notice, and comparing it with the size (about five inches in extent) of this vertebra, as shown by the engraving, it occurred to me that it may perhaps be referable to a species of *Megatherium*. This supposition is not precluded by the comparison made by Mr. Pentland, at Paris, for there is no skeleton of the *Megatherium*, nor even I believe a single bone of that animal, in the Parisian collection, the skeleton at Madrid being the only one at present extant in Europe. The resemblance of the vertebra, in the nature of the articulation, to the sloth and ant-eaters, accords exactly with the ascertained characters of the osteology of the *Megatherium;* while its approach in other respects to the character of the *Pachydermata*, is in agreement with the relations connecting the *Edentata* and *Pachydermata* in the series of mammiferous animals, which have been recognized by many naturalists, especially by Linnæus and Cuvier. The former naturalist placed all the *Edentés* of Cuvier with which he was acquainted, in his own order of *Bruta*, in which were also included the *Pachydermes* of Cuvier; and the latter, in his *Leçons d'Anatomie Comparée*, makes his tribe of the *Tardigrades* (to which the Sloth and the *Megatherium* belong) the means of transition from the other *Edentés* to the *Pachydermes;* and though he has not followed this arrangement in his later *Règne Animal*, he has in that work repeatedly alluded to the connexion between these groups*.

It will probably be difficult if not impossible to decide this point

animals of warm climates, belonging to genera very different from the Elephant, are thickly covered with hair and wool, but that the two existing species of the *Elephant* itself, both inhabiting warm climates, are devoid of such a covering. This seems to be a more direct (converse) analogy, in favour of the supposition that the Siberian elephant was adapted to live in a cold climate, than those mentioned by Dr. Buckland are, in favour of the opposite view of the subject.

I may also observe, in conclusion, that the facts cited by Cuvier, and regarded by him (in the extract given by Dr. Buckland at the end of his memoir) as refuting the hypothesis of the gradual refrigeration of the earth, merely show the *last* change of temperature to have been sudden, and leave the validity of that hypothesis, as to all preceding changes, unimpugned.

* See Mr. W. S. MacLeay's "*Remarks on the Comparative Anatomy of certain*

point without actually comparing the vertebra with the corresponding bone of the *Megatherium*. The comparison of the figure given by Dr. Buckland with the description and engraving of the bones of the *Megatherium* contained in the last edition of Cuvier's *Ossemens Fossiles*, afforded no decisive indication on the subject, either negative or affirmative. Whether a similar comparison with the plates of Pander and D'Alton would lead to a satisfactory determination, I am not aware; and in this deficiency of evidence I mention my supposition, for the purpose of drawing attention to the subject. It is probable that the means of actual comparison with the *Megatherium* will shortly be afforded, by the arrival in England of a perfect skeleton of that animal, recently announced as having been obtained by Mr. Woodbine Parish, at Buenos Ayres*.

Should this vertebra ultimately prove to have in reality belonged to a species of *Megatherium*, the fact will lead to further interesting results. An important object of inquiry will be, whether the *Megatherium* was co-extensive on both continents, with the extinct elephant, or whether, like the sloths, and the ant-eaters (*Myrmecophaga*, Linn.,) to which it is allied, it was confined to the New World, where, alone, the bones of the *Megatherium* also have yet been discovered†. The localities in which the latter have hitherto been found, including that of the skeleton in the possession of Mr. W. Parish, are included within the parallels of about 40° south, and 40° north latitude; and the remains of the allied genus *Megalonyx* have occurred only between the parallels of 30° and 40° north.

All these remains, I believe, have been found in superficial deposits of clay and gravel, &c., or in caverns; and under circumstances which would have caused them to be referred to the "Diluvial" era, until the recent discriminations on that subject; but their history is at present too little known, to permit us, in the actual condition of science, to point out, determinately, the epoch to which they belong. The view which Dr. Buckland has taken of the mode of destruction of the extinct Elephant, is equally applicable to the *Megatherium*, if they were coexisting animals.

16, St. James's Street, Clerkenwell, May 20, 1831.

certain Birds of Cuba," in the Transactions of the Linnæan Society, vol. xvi. p. 25, 27—29, 37—40; and Cuvier, *Règne Animal*, (edit. 1829) tome i. p. 223, 236.

* See Prof. Jameson's Journal, January—March 1831.

† The remaining fossil animal belonging to the *Edentata* is at present known only from a single ungueal phalanx, of gigantic size, found, together with bones of *Pachydermata*, both of extinct and still existing genera, in sand and gravel, at Eppelsheim in the Palatinate. Its living analogue, the Pangolin (*Manis*, Linn.,) is confined to the Old World.—Cuvier, *Ossemens Fossiles*, tom. v. 1re partie, p. 193; *Règne Animal*, tom. i. p. 232—233.

LXIII. *Obser-*

LXIII. *Observations relative to the Origin and History of the Bushmen.* By Andrew Smith, *M.D. M.W.S. &c.*

[Concluded, from page 342.]

IN the art of carrying off their pillage, they are extremely dexterous; and in the practices of deception on such occasions they are peculiarly expert. They sometimes commit their depredations during the day, when the flock and herds are dispersed in the fields, but more frequently at night, when they are collected for rest. Should necessity permit of their exercising a choice as to time, they commonly prefer the decline of the moon, so as to have the benefit of darkness to assist them in the commission of the act, and the aid of light to facilitate in the carrying away of the spoil. The existence of rainy weather they also regard as favourable for such pursuits, on account of fire-arms being then less available; but, nevertheless, the circumstance of footmarks of every description being more distinctly imprinted at such times, whereby they can be more readily traced, often prevents them from availing themselves of the advantage in question. Having once got possession of cattle, they invariably carry them across the most parched and arid spots, and regularly in the directions where water is least abundant, in order to incommode their followers, or render pursuit impossible. If at the time they commit their outrages, the country through which they intend to return be very dry and destitute of water, they furnish themselves before they commence the expedition, with a number of ostrich shells filled with that fluid, and those they deposit successively in holes of the ground during the approach to the scene of their intended operations, whereby they supply themselves on their return with what may be necessary to quench their thirst. By these arrangements they readily continue their retreat when their pursuers are forced to turn back, and by such practices they often set at defiance the endeavours of commandoes, either to destroy them or retake cattle. When they succeed in the object of their enterprise, they either betake themselves to a convenient water-place, or else to the spot where their families reside, and there kill and eat till all be consumed. If it happen that the means of pasturage occur in the vicinity of the place resorted to, they sometimes permit what is not immediately required, to exist, till what they may have slaughtered be eaten; but when such is not the case, or when there is a chance of the persons plundered descrying their retreat, they prefer destroying all at once, and

either

either allowing a portion to go to waste, or to be consumed when even far advanced in putridity.

When in the act of driving away either cattle, sheep, or horses, they are pursued and approached, they immediately commence destroying them; and as soon as that is completed, they betake themselves to flight*. Should, however, they discover that by the time they have effected the first of those objects, the latter cannot be achieved, they prepare for defence, and then according to circumstances, either are satisfied with attempting that in exposed positions, or else from behind rocks or stones; or, if time will permit, from holes formed in the ground. The dexterity and quickness with which they often form the latter, is matter of great wonder with the colonists; and I have been told by persons who have been much in the habit of observing them in such situations, that almost in the course of a few minutes they will model cavities, in which two or three can conceal themselves, and avoid in a great measure the effects of fire-arms. From such positions they send forth their arrows with great precision, and while in them they are regarded as nearly upon an equality with their opponents.

* Field Cornet Louw, of the Aghter Hantam, writes, "I received a report on the 20th November, 1829, from the Burgher Hendrik Johannis Rygert, stating that five Bushmen had taken away, between the place of Middle-kraal and Slang Fonteyn, three black cattle and two horses, belonging to Hendrik Wolfgraaf, when, having driven them a short distance, they shot them dead. I immediately ordered out a commando, and proceeded on the 23rd following, as far as the place Hinger Fonteyn, to discover their tracks and the road they had taken. I there ascertained that they had taken some more horses. I then proceeded nearly as far as the Fish river, where was a Bushman kraal, and finding that the aforesaid Bushmen had reached it before me, and had broken it up and gone to a greater distance, I resolved to return, the more on account of want of water. On arriving at Hendrik Visage's he informed me that five Bushmen had again been in the colony, on the Hantam mountains, and that he had sent three bastards on their tracks. I then directed my commando to remain for the day, in order to call in the assistance of more people, as thinking it not strong enough. One of the bastards ordered by me having gone to the place Brandwacht, to fetch his horses, discovered that the said Bushmen had taken two the day before. Following their tracks he found they had driven them into a deep kloof near the place; but being afraid to pursue them further, he returned to us to report the same. In consequence of the information, I repaired to the place the same evening, with my commando, and at a late hour sent out spies to see whether they were still in the kloof, but they made no discoveries. I subsequently took the same thither, and came to the spot where it appeared, by the remains of the horses, that they had been feasting upon their flesh, having previously pierced them with arrows. Still following their track, I at length arrived at my own place, where, about 1000 yards from the house, I found they had driven off my horses, and at the distance of about half as much further, they had stabbed four of them and shot others with poisoned arrows, so as to cause their death. Still in pursuit, we

opponents. If when they are detected they be in the vicinity of rocks or mountains, they, after securing their plunder in the way already described, retreat to those with amazing rapidity, and from thence conduct their defence so dexterously and effectually, that seldom are they overcome. They shelter themselves so completely behind the rocks, that shot can produce little or no effect, and the uncertainty of their actual resorts renders the assailants little disposed to venture upon a close approach. When in such positions, as well as when in holes of the ground, the only effectual way in which they can be secured or destroyed, is by approaching them under the cover of a large shield, formed of the dried hide of an ox, or of a hard rush or reed mat, and carried by one person, while another accompanies him prepared for an actual attack. Through those articles, the arrow will not penetrate so as to produce much effect; and therefore, if they are not in considerable numbers, or so close as that in advancing to one, others are so situated as to be enabled to act with success, they may thus be subdued, and frequently are so, both by the frontier farmers, as well as by the Namaquas, River Hottentot,

we found five more of my horses lying dead, one upon another, and on a rocky rising ground, between the places Brandwacht and Malpes Fonteyn, the robbers themselves. Here they defended themselves to the last extremity, in consequence of which, two of them were killed by the commando."—MSS.

A gentleman, who lately happened to be on the northern frontier of the colony, at a time when the Bushmen had stolen 1200 sheep, says, " A commando, which I accompanied, pushed forwards as fast as possible upon the traces of the thieves, and it was most lamentable to see the track so strewed with dead sheep which had been destroyed by the plunderers. It appears," he adds, " that the Bushmen never leave behind them any cattle alive which, from fatigue, cannot go on, but invariably kill them with poisoned arrows." When they overtook them upon a high and rocky hill, they appeared much confused, but immediately dispersed themselves and got behind rocks, from whence they showered their arrows upon the farmers. Of those the writer brought away two hundred.—MSS.

" On the morning which was fixed for our departure," says Mr. Kicherer, " one of our cows came home with an arrow sticking in her flank. We immediately concluded that the Boschemen had driven away part of our herd. In these cases, they oblige the cattle to run as fast as they can, and when any of them are unable to keep up with the rest, they pierce it with a dart; in consequence of which, it falls on the road, and the carcass is fetched away by the robbers on the following day. The cow which returned to us had been thus treated, and served as a messenger to apprize us of what had happened. I dispatched some Hottentots with fire-arms to pursue the track of the banditti; and in the mean time travelled on with the remainder of the caravan. On the next day, my people joined us with seventy-three out of eighty oxen, which had been stolen from us. They had happily fallen in with the robbers, at the distance of a long day's journey beyond the hills, and recovered the property; but two of our horses had been killed by the fatigue."—*Transactions of the Missionary Society*, vol. iii. p. 12.

Hottentot, and Caffres. On such occasions, however, when the defendants perceive that their efforts are likely to be ineffectual, they are apt to rush forth from their hiding-places, and approach with such a rapidity and ferocity as not unfrequently secures them a victory.

Much difference of opinion exists as to their skill in the use of the bow: some certainly are very dexterous therewith, and will almost to a certainty, at a very tolerable distance, strike any object of moderate size, while others are less certain of their aim; but as a general position, it may be admitted that the majority will not shoot many times without effect, at a distance of sixty or even eighty yards, when the object in view is equal to the dimensions of a man. As those weapons form their only articles of defence, as well as the means of procuring a large proportion of their food, expertness in the use of them is a principal object of study, and one of the most frequent amusements even of their early years. Every Bushman youth is furnished with his bow, and even the infant at the breast is frequently so supplied. In the construction thereof, almost all their art is centered; and in giving them the form and character best calculated for their particular objects, much ingenuity and cunning are often displayed. The bow varies in size amongst different hordes, being with some between four and five feet in length, and with others not more than three. It is made of various sorts of wood, but such as are strongest and most elastic are usually preferred. The string by which it is bent, and held in a condition fit for immediate use, is formed either of the dried intestines of quadrupeds, or else of the lacerated and otherwise prepared tendons of animals. The arrows differ in length according to the bows, but seldom extend beyond two feet or two-and-a-half. They are formed of strong reed, about the thickness of a writing quill, and with one extremity fitted to embrace the string of the bow, and the other to receive a piece of cylindrical bone of nearly the same circumference as the reed itself, and on which is fixed the article for inflicting the wound. In some cases, the latter is of fine stone formed into a somewhat triangular shape, and in others it is of iron, constructed so as to ensure most effect to its operation. On the portion of the arrow immediately behind the part destined for cutting or puncturing, is the poison spread, and that in such a way as completely to encircle about two inches of it. In many specimens immediately behind that, the shaft is cut more than half across, so that the slightest motion after it penetrates, or the least attempt to withdraw it, does generally occasion the separation of the major part from that which bears the poison; and on the site of the latter is also frequently

frequently attached a small barb of quill or fine iron, so as to assist more effectually in rendering extraction almost impossible. With the view of ensuring the arrow a straight course when ejected from the bow, they in common with all others who use the like instrument, attach a portion of feather to its hinder extremity. Of such, thus completed, every Bushman will perhaps be supplied with fifty or sixty, and those he carries in a sort of quiver, formed of the bark of the Kokkerboom, from which the woody part has been excavated. When, however, in a state of war, or in pursuit of game, he generally holds more or less loose in his hand, and when about to shoot, always places them in a convenient situation upon the ground.

The poison they employ is manufactured in various ways, so as to concentrate and render it adapted for application to the arrows. The most virulent sort, and that which they usually employ when they go against their enemies, is chiefly composed of the poison of snakes; the next to that is one obtained from the larvæ of an insect, found upon a bush growing near the Orange River; and the third is of vegetable origin, and called the malkop poison, on account of the peculiar effects it produces upon the senses. This last is not considered so serious in its consequences as either of the others, and is the sort commonly employed upon arrows destined for killing game.

Such then are a few of the points of interest connected with the history of the Bushmen; and though far from exhausting the subject, or even including all that my own notes would afford, yet I am induced to conclude for the present, with an earnest recommendation to such of the members as may have been in the habit of observing our savage tribes, to embody their remarks for occasions like the present; as by such proceedings they may advance their individual reputations, at the same time that they acquire a consequence and character for our institution, which must be dear to all of us who feel a pride in the success of enterprizes in which we have a share.

LXIV. *Theory of the Telescopic Level. By* John Nixon, *Esq.**

A TELESCOPIC level of the *most simple* construction, would consist of a refracting telescope with adjustable cross wires fixed within a perfectly cylindrical tube; the latter having attached to its surface (by means of adjusting screws) a spirit-level, placed parallel to the direction of its axis.

* Communicated by the Author.

When

When in use, the telescope would rest within a trough formed by the junction of two planes (equally inclined to opposite points of the horizon, and secured to the surface of the upper parallel-plate of a tripod. In order to diminish the weight, without affecting the accuracy of the instrument, the artist makes a section of the trough, perpendicular to the line of junction of its sides, within a short distance of each end, and removes the whole of the intermediate part. These sections, or notches, (called Ys from their resemblance to that letter,) will be exactly opposite and parallel to each other, and have the same angular opening.

A spirit-level is a closed glass tube, nearly filled with spirits of wine, fixed to a straight bar, of which the under surface is a plane. A line drawn on this under surface in the direction of a plane passing through the axis of the tube, we shall call the *reversing line* of the level.

(For definitions of vertical, horizontal, and inclined lines and planes, see "The Theory of the Spirit-level," Phil. Mag. and Annals, N.S. vol. i. p. 256.)

The reversing line of the level being placed, in opposite directions, in contact with a horizontal line, the bubble, considered as a point, will come to rest, in both instances, at the same point of the tube called the *reversing point.* A level may be placed in any direction in contact with a horizontal plane, without displacing the bubble (from its reversing point). When a level can be placed in contact with a plane in any two directions at right angles to each other, and reversed in both without deviation of the bubble, that plane is horizontal. When the reversing line of a level is placed in two opposite directions in contact with an inclined line, and the place of the bubble is marked in both instances on the tube, the distance between the two marks, converted into an arc of a circle, will be double the horizontal inclination of the line;—the reversing point lying between and equi-distant from the two marks. In a revolution of the level in contact with an inclined plane, the bubble would be twice at the (reversing or) same point of the tube; occurring when the reversing line of the level was in the direction, and in the *opposite* direction of one of the horizontal lines, which may be drawn (parallel to each other) through any point of an inclined plane;—and twice, when at right angles to these directions, the bubble would be at the same and maximum elongation from the stationary or reversing point, but on opposite sides of it; the equivalent angle of the linear space passed over by the bubble being the double of the horizontal inclination of the plane and line.—Parallel lines are either all inclined, or all parallel to the horizon.

When

When any point of an object viewed through a refracting telescope is intercepted or apparently covered by the intersection of its cross-wires, that point of the object is in the direction of a straight line, termed the line of sight or collimation, passing through the intersecting point of the wires and the centre of refractions, or thickest part of the object-glass. When the telescope and wires are properly adjusted, the eye may be gradually withdrawn laterally from its original position in front of the eye-glass, without perceiving the least parallax, or deviation in the direction of the wires. Were wires, substituted for the object-glass, made to cross each other at the precise point previously occupied by its centre of refractions, we should find, on withdrawing the eye-tube, that a straight line passing through the intersection of the original and that of the substituted cross-wires (together forming what are called plain sights), would be in the direction of the same point of the object observed. The centre of the object-glass is known to coincide with that of its cell, and is consequently situated in, or very nearly in, the direction of the axis of the cylindrical tube, when the line of collimation, during a revolution of the glass within its cell, does not deviate from the object to which it was previously pointed. All the rays of light from a fixed star which enter a telescope are sensibly parallel to each other, but converge, after having passed through the object-glass, to a point (?) within the tube at a distance from the object-glass, called the sideral focus. Hence rays of light passing out of a telescope from the point of intersection of the wires, placed at the sideral focus, are inclined to each other, and diverge until they reach the object-glass, in which they suffer refraction, and emerge perfectly parallel to each other*. When two telescopes, properly adjusted with their cross-wires at the sideral focus, are placed nearly in a line, but in opposite directions, the wires of the further telescope, on looking through the nearer telescope, will appear perfectly distinct, whether the two object-glasses are in immediate contact or at a distance from each other. In either case, if the intersecting point of the wires of the nearer telescope is made to coincide with or intercept the view of the intersecting point of the wires of the further telescope, the lines of collimation of both telescopes will be strictly parallel to each other†. They cannot however be in one line (or direction), unless (—which we cannot ascertain (?)—) the centres of refraction of both object-glasses and the intersecting points of both cross-wires are all in the same straight line. Hence we

* Prof. Gauss of Gœttingen. † Prof. Bessel of Kœnigsberg.

may move either telescope in a parallel direction to a higher or lower level, or laterally; yet its wires, whilst visible, will still appear to cover at their intersecting point, that of the wires of the other telescope. Rays of light falling upon an object-glass from a distance within ten miles are sensibly divergent, and form their focus within the tube at a greater distance from the object-glass than the place of the sideral focus.

A straight line revolving about a parallel fixed line or axis at a constant distance from it, describes the longitudinal surface or sides of a cylinder. In the revolution of a cylinder about its *fixed* axis, every point of its sides describes a circle, to which that axis, passing through its centre, is perpendicular. The longitudinal lines, formed on the surface of the cylinder at any points of it, by planes passing in the direction of its axis, are parallel to that axis and to each other. When the sides of a cylinder press equally against a plane, the points of *tangence* form a straight line parallel to the axis of the cylinder. Sections of the cylinder by (parallel) planes passing perpendicular to its axis are circles, all of equal diameter, having the axis of the cylinder in the centre;—and the intersections by the *same* plane of the one in contact with the cylinder, will be as many parallel straight lines, tangents to, (and in the plane of) each corresponding circle of the section. A circle cannot come in contact with two lines inclined to each other, except at a point in each equally distant from the point in which they meet (the distance varying with the angular inclination of the lines). If we press a second plane, inclined to the first in an opposite direction, equally against the other side of the cylinder, transverse sections of the cylinder perpendicular to its axis, passing also through the two planes, will be circles, equal in diameter, in contact with two (tangential) lines inclined to each other at a constant angle, and the line of junction of the two planes will be parallel to the axis of the cylinder. A plane passing in the direction of the axis of the cylinder and that of the line of junction of the two planes will be equally inclined to both planes. The cylinder, in performing a revolution about its fixed axis, will always be in contact with the same points of the two planes, which points form two lines parallel to the axis of rotation or that of the cylinder, and to themselves. When the cylinder is taken out of the trough formed by the two planes, and replaced within it reversed in direction, its axis must be situated in the same line as before, but in the opposite direction, because transverse sections of the cylinder and trough will still be circles of the previous diameter, in contact with two lines inclined

inclined to each other at the same angle as before. Consequently the cylinder, although reversed, is in contact with the trough at the former points, which lie in a line parallel to the axis of the cylinder and to the line of junction of the sides of the trough.

Demonstration that the Line of Collimation of a perfect and well-adjusted Telescopic Level is truly horizontal.

When properly adjusted, the position of the ends of the bubble relative to the level-tube being marked, the telescope (cylinder) may be taken out of its Ys, and replaced, reversed in direction, yet the bubble will come to rest at the mark previously made on the tube. Also, on making the telescope perform an entire revolution within its Ys, the point of intersection of its wires will continue to intercept the same point of the distant object observed.

Now as the line of collimation remains constant in direction during a revolution of the telescope within its Ys, it is evidently situated in or parallel to the axis of the cylinder, and is also parallel to either of the longitudinal lines on each side of the surface of the cylinder where in contact with the interior of the Ys, which latter are equivalent to the transverse sections of the two inclined planes or trough in contact with the cylinder.

Again: as the cylinder will suffer reversing within its Ys without displacing the bubble, it follows that both these lines of contact are parallel to the horizon; and being also parallel to the line of collimation, the latter is perfectly horizontal.

Or, more simply: as the cylinder when reversed in the Ys has its axis in the same line as previously, and the reversing does not displace the bubble, the axis, and consequently the line of collimation, which is proved to be parallel to it, are horizontal.

In order to simplify the demonstration, the Ys have been considered as equal in angular opening. To prove that any inequality would not vitiate the instrument, we will furnish it with two additional Ys, one wider, and the other narrower than the pair of equal Ys, in which the telescope, adjusted for observation, is supposed to rest. Our object being to place each additional Y with both its sides in contact with the cylinder without disturbing the latter, we shall find it requisite to lower the narrower Y, and raise the wider one; which will bring the one to touch the cylinder above, and the other below the level of the points of contact of the adjacent original Ys. Nevertheless, on reversing the cylinder, as it is of one diameter throughout its length, its contact with the four Ys

 will

will take place at points in each Y, and at perpendicular distances below its axis, the same as before reversing. Consequently we might remove the original Ys, subsequent to reversing the telescope, without altering the place of the bubble.

It is also sufficiently evident, that when the Ys are not exactly opposite to each other, (in which case they may be represented by sections of the trough oblique to the line of junction of its sides,) the cylinder will reverse within them precisely the same as though they were parallel.

The *error of collimation* of a telescopic level is the angle (measured on a vertical plane) expressing the inclination to the horizon of the line of sight or collimation. When the error is derived solely from imperfection in the instrument, it is termed *constant* or *instrumental.*

When the tube in which the telescope is placed is conical, or its ends are two cylinders of unequal diameter, the line of collimation, supposed level, will have a constant elevation or depression, accordingly as the object-glass is situated at the wider or narrower end of the tube.

Let us trace the consequences of increasing the diameter of, for instance, the object-glass end of the cylindrical tube of a perfect telescopic level adjusted for observation. In the first place, the thicker or object end of the tube will now come in contact with its Y above its former perpendicular height, without affecting the other or eye end; and the displaced bubble must come to rest at a point of its scale nearer to the object-glass. On reversing the tube, as the Ys are equal and their angular points are level with each other, neither the object nor the eye end of the tube suffer any consequent change of perpendicular height; the telescope is equally elevated after as before reversing, and the bubble must settle at its new mark.

The elevation indicated by the displacement of the bubble forms only a part of the error. When the tube was cylindrical, its axis would be at a perpendicular height above the angular point of either Y, by a quantity equal to the secant of the complement of the angular opening of the Y multiplied by the radius of the cylinder. But in increasing the diameter of the object end of the tube, we have proportionately increased the height of its axis, at a point of it exactly over the Y in which it rests, whilst its height over the other Y may be considered as unaltered. Our conical tube will therefore reverse in equal Ys (of which the angular points are level with each other), without displacing the bubble (from its new position); yet the line of collimation (which may be adjusted to be fixed during

a revolution

a revolution of the tube within its Ys) will be constantly elevated at an angle of which the tangent is the (calculated) increase of perpendicular height divided by the distance between the Ys.

When the instrument is set up ready for taking levels, the upper surface of the tube* at the object end is at a greater elevation than at the eye end, by the difference of the semidiameters of the tube (measured over each Y), added to the corresponding augmentation of height of the axis. As the angles are minute, the horizontal inclination of the surface of the tube will be to that of its axis, (or to the error of collimation,) as the augmented perpendicular height of the former is to that of the latter. When the Ys open at 90 degrees, the ratio will be as 2·414 to 1·414.

In the case of the Ys being unequal, the error will be the mean of its value calculated for each Y. Supposing one of them (X) to open at 90°, and the other (Z) at 88°; and that the radius of the eye end (A) of the tube is 1·0, and that of the object end (B) 1·2. When A rests within Z, the height of the axis is 1·440, and 1·697 with B within X; so that it is more elevated over X than over Z by 0·257. On reversing the tube, A rests within X at a height of 1·414, and B within Z at a height of 1·728; the axis being higher over Z than over X by 0·314. But if we lower the narrower Y by 0·0285 (or half the difference), then will the elevation of the axis, before and after reversing, be equal to 0·2855, or to the tangent of the constant error of collimation.

The following methods of ascertaining the instrumental error are the most feasible of those that have occurred to me. The result of each, on its application to determine the error of the horizon-sector, will be given hereafter.

I. Find by a spirit-level, placed on the surface of the tube, its inclination to the horizon.

II. Place a vessel filled with quicksilver between the object-glass of the instrument and that of another telescope†, and observe through the latter the intersection of the cross-wires of the former direct and by reflection.

III. By Captain Kater's horizontal floating Collimator.

IV. Make the lines of collimation of two telescopes parallel to that of the instrument, and afterwards point the telescopes at each other with the bubbles of their levels at their marks.

V. Or measure by the instrument the minute inclination of

* Or, more correctly, of the line formed by the intersection of the upper surface of the tube by a *vertical* plane passing in the direction of its axis.

† In every case the telescopes are understood to be adjusted to the sideral focus.

the

the lines of collimation of two telescopes previously made parallel to each other.

VI. Compare *two* sets of observations, one of which was made before, and the other after the object-glass and eye-piece had been taken out of the instrument and replaced reversed in situation.

VII. Fix one spirit-level to the upper surface, and another to the under surface of an inflexible bar attached to the telescope. Make observations with the latter direct and inverted, and repeat them with the bar reversed in direction.

VIII. The error may be found by the double level affixed to the tube, without reference to the telescope.

IX. Were the bar of the double level moveable about a short horizontal axis projecting from either side of the tube, it might be inverted by making it describe exactly half a revolution. The two levels could then be made parallel to each other, and the reversing of the bar would be unnecessary.

X. Place the instrument between two telescopes pointing at each other. Then make the line of collimation of the instrument parallel to that of either telescope, and reverse it within its Ys, which will bring its object-glass opposite to that of the other telescope. Having made the line of collimation of the latter parallel to that of the instrument, observe the difference of inclination, or deviation of parallelism of the lines of collimation of the two telescopes, the instrument being removed from between them.

XI. Take out the eye-tube and substitute an object-glass placed at a distance from the wires equal to its sideral focus. Point another telescope at, for instance, the original object-glass, and make their lines of collimation parallel. Reverse the instrument within its Ys, and note the deviation of parallelism of the lines of collimation of the additional object-glass and that of the (proof) telescope.

[To be continued.]

LXV. *Notices respecting New Books.*

Illustrations of the Geology of Yorkshire; or a Description of the Strata and Organic Remains of the Yorkshire Coast: accompanied by a Geological Map, Sections, and Plates of the Fossil Plants and Animals. By John Phillips, *F.G.S.,* Keeper of the Museum of the Yorkshire Philosophical Society, &c. *York,* 1829. 4to. pp. 192. *Twenty-four Lithographs.*

[Concluded, from page 354.]

THE third chapter, containing descriptions of the Coast of Yorkshire from Spurn Point to Redcar, is illustrated by a coloured geological

geological map of the north-eastern part of the county, and a complete section drawn to scale, of the whole range of the cliffs, besides several enlarged representations of the more interesting parts.

We request the attention of geological students who may be preparing to publish the results of their investigations, to the subjoined remarks by Mr. Phillips on the colouring adopted in his sections, &c.

"With regard to the colouring, the natural prevailing hues of the strata have been generally imitated; but where two rocks could not be thus well discriminated, the difference of their tints has been necessarily exaggerated. It is a common opinion that all geological works should be coloured upon one model; but what model shall we follow? No geological *map* can possibly be so filled with colours as to embrace all the minor subdivisions of rocks which, in *local sections*, it would be unpardonable to omit. Besides, the colours of rocks vary, and circumstances may make it desirable that sometimes a stratum should be coloured strongly to mark its importance, though at other times it would be better represented by a fainter shade. However, to increase as little as possible the confusion of colours which already exists, I have followed in the colours of the oolitic rocks the works of Mr. Smith, and have preferred with Mr. Greenough, to leave the chalk white. Where rocks were to be thus represented for the first time, I have used such colours as have not been before appropriated."

From Spurn northward to Bridlington the whole line of the cliffs is composed of various bands of diluvium, which the author, permitting himself to deviate from the ordinary English notions of the deluge, attributes to different periods of diluvial agency. In detached hollows on the surface of this diluvium, to the height sometimes of eighty feet above high water, lie no less than twenty-five lacustrine or freshwater formations, with shells, peat, hazel-nuts, broken trees, and bones of deer and other animals. The following passage conveys a good notion of the ravages of the sea on this wasting shore: pp. 59, 60.

"Spurn Point, the southernmost part of the coast of Yorkshire, is a low peninsula of gravel and sand, accumulated by the sea and the wind, and laid in its peculiar forms by the united action of currents from the sea and the Humber. The materials which fall from the wasting cliffs between Bridlington and Kilnsea, are sorted by the tide according to their weight and magnitude; the pebbles are strewed upon the shore, beneath the precipice from which they fell; the sand is driven along and accumulated in little bays and recesses; whilst the lighter particles of clay are transported away to the south, making muddy water, and finally enter the great estuary of the Humber, and enrich the level lands under the denomination of warp. The sand and pebbles, which were at first deposited near the place where they fell, are afterwards removed further and further south by the tide, and the cliffs are left exposed to fresh destruction. Thus the whole shore is in motion, every cliff is hastening to its fall, the parishes are contracted, the churches washed away, and not unreasonable fears are entertained that at some time the waters of the ocean and

and the Humber may join, and the Spurn become an island. At present, however, the isthmus stands firm, and though composed only of a heap of pebbles and sand, and exposed to two strong currents, may, perhaps, be little changed for ages to come. Such is the efficacy of long equal slopes and a pebbly sand, in repelling the rage of the sea."

It is impossible without the sections to give any adequate notion of the curious variations in the diluvium and alluvium described in this part of the work. It is a subject of the greatest interest, and apparently few districts are more favourable for the inquiry than Holderness. The author gives the following summary of his observations on the subject: p. 68.

"From the preceding description of the coast of Holderness, it is evident that no formations appear there which can be considered as older than the deluge. Of the diluvial accumulations, by far the most prevalent, that which is the base of the whole cliff, is blue and brown clay, containing dispersed pebbles; above this, a more local deposit of undulated laminated clay; and finally, gravel on the top, or mixed with the pebbly clay. In this formation lie the teeth and tusks of antediluvian elephants, and abundance of water-worn fossil shells, derived from neighbouring and remote districts. Resting on these diluvial beds, we find the deposits of later, more quiet, more contracted waters. Lakes, which existed in hollows of the deluge-worn surface, have been slowly filled up by clay marl, shells, and peat, subsiding from their waters, and either drained by the industry of man, or emptied by the approaches of the sea. The shells which occur in these clay beds, belong to fresh-water species now living; they lie almost invariably at the bottom of the bed of the lake, and are covered by several feet of clay and peat *without shells*, a circumstance which seems to warrant the supposition that the upper layers of sediment and peat were produced in some short period of time, in consequence, perhaps, of great land-floods.

"In these deposits lie the skeletons of postdiluvian animals; the great extinct elk, the red deer, the fallow deer, and the ox; with trees and fruits, which grew in the forests they frequented. In more than twenty examples on the coast south of Bridlington, it may be clearly seen that the lacustrine deposits rest upon the diluvial accumulations; but are not themselves covered by any other deposit. It is a mistake, therefore, to imagine the skeletons of deer, and the peat and trees constituting the 'subterranean forest of Holderness,' to be of the antediluvian æra. The shells, bones, and trees, belong, with a single exception, to species now in existence in this island, the deposits which enclose them are evidently the most recent in the country; and differ in no important particulars from the peat and marl-bogs of Scotland and Ireland, whose accumulation is not yet ended."

From this section, also, we extract a notice on the indications of *Tertiary Beds* in Yorkshire, as the history of these formations, principally from the labours of Messrs. Murchison, Sedgwick and Lyell, has of late become so important a branch of geology.

"*Tertiary beds.*—One of the most important inquiries that presents

sents itself to the geologist, whilst investigating the coast of Yorkshire, relates to the occurrence of any of the tertiary beds above the chalk; and Mr. Smith has stated, on his geological map of Yorkshire, that crag shells occur in the neighbourhood of Pattrington. These I have previously described, and cannot doubt that they belong to the diluvial epoch. Professor Sedgwick, who examined the spot in 1821, describes appearances on the north side of the harbour at Bridlington, which he supposed to indicate the presence of some one of the strata above the chalk. I have repeatedly searched, without success, for these beds; but in July, 1828, I found, sixty yards north of the harbour, below the level of half tide, an enormous mass of dark shaly clay, whose laminæ seemed dipping to the south. It was several yards in length and breadth, was surrounded by brown pebbly clay, and contained a few fossils, amongst which were a peculiar ammonite; the columnar joints of Pentac. Briareus, and what I believe to be a form of Avicula inæquivalvis. I was at first much disposed to think this a portion of a tertiary stratum, and still am altogether at a loss to explain the appearance of so enormous a mass of perishable clay, having the appearance of lias, at such a distance from the nearest cliffs of that stratum. I recommend this point for further observation. The specimens of Pholas crispata washed ashore full of coherent sand, prove nothing whatever on this subject: such dead shells are particularly liable to be filled with the matter on the bed of the sea; and the only remarkable circumstance in these specimens is, that the matter which they contain is unusually solidified. Excepting those imperfect indications, I have never heard of a single fact which would authorise a belief that tertiary strata exist in Yorkshire."

The description of the Flamborough Cliffs gives occasion to reflections on the origin of caves and the wasting effects of the sea.

"The origin of many inland caverns in limestone is exceedingly obscure. Though water flows through many of them, and by incessant attrition smooths their surfaces, and modifies their forms, yet, perhaps, we ought rather to believe that the cave, originally existing, directed the course of the stream, than that water excavated the cave. By the sea side it is otherwise; the destructive action of the sea is not doubtful; the cliffs crumble before its salt vapours, and waste away under its furious waves. One loosened stone beats down another, and thus the soft parts are hollowed out, whilst the harder portions jut into promontories, or stand naked in the water. If the soft parts, exposed to the waves, be enclosed in firmer matter, caves and arches are formed, which are afterwards liable only to slow alteration: but if these yielding materials extend far in a horizontal direction, the cliff undergoes rapid diminution. These observations are of general application. Projecting capes and headlands are usually composed of firmly-compacted strata, whilst bays and estuaries commonly present less resisting materials. Between the north landing-place and a more remarkable bay to the west, the prominent cliffs are one hundred and seventeen feet high, and mostly composed of chalk; but at both these bays that stratum sinks low, and is covered by a vast accumulation of diluvium. These unsolid materials fall and waste

away into slopes, which often become covered with grass, and afford a dangerous pasture for cattle and sheep. But on the west side of the remarkable bay before alluded to, the diluvium is subject to such continual waste, that it appears in the form of bare pinnacles resting upon the caverned chalk."

The chalk of Yorkshire has a red layer in its lower part*, and rests on blue clay containing Hamites and other characteristic fossils of the gault. Neither the upper nor the lower green sand has yet been found in Yorkshire.

It is impossible to abridge the detailed descriptions which apply to the Coralline oolite, Bath oolite and Lias formations; and we therefore hasten to the next chapter, perhaps the most valuable of all, which treats of the Organic Remains.

This is a subject for the illustration of which Mr. Phillips's situation and habitual studies have especially qualified him. Having the direction of a rich county museum, with unrestrained access to several other public collections, and more than twenty private cabinets, he has been enabled to apply his knowledge of natural history with uncommon effect. More than 500 species of organic remains, 220 of them new, are described and faithfully referred to the strata in which they occur, with notices of every ascertained case of repetition in different strata, whether in Yorkshire or in other parts of England.

Of these, 400 species, drawn by himself, are represented in fourteen Lithographic Plates, in the order of the strata to which they respectively belong; and thus in the best possible manner the student is presented with an epitome of the whole subject.

Such an arrangement could not have been accomplished without the facilities above alluded to; and the frequent repetition of the names of Bean and Williamson, while it establishes the claim of those gentlemen to the reputation of diligent collectors, secures for them the still higher praise due to the zealous promoters of science.

The detailed catalogues of the fossils, in the strata from the chalk to the lias, are preceded by an essay on Organic Remains in general,—what tribes of animals and plants are buried in the earth, in what state of conservation and degree of perfection they are severally found,—what mechanical and chemical changes they have experienced.

The still more important subject of the distribution of fossils in the earth, not long since under examination, in our pages, by Mr. De la Beche †, is fully discussed, and the principles elucidated by which modern geologists are enabled to conduct their researches into the relative antiquity of different rocks, and the circumstances under which they were accumulated.

The following are extracts:—

"*Distribution of Fossils.*—Modern naturalists have discovered in the earth the remains of several hundred different plants, and several

* Does the occurrence of this red layer point to any mineralogical connection of the Yorkshire chalk with the partially red rock called the *scaglia*, which is the equivalent of the chalk formation in the Alps?

† See Phil. Mag. & Annals, N.S. vol. vii. p. 81. *et seq.*

thousand

thousand kinds of animals. The peculiarities of form and structure among fossils are as constant and defined as among the living productions of nature, and the species are often as well distinguished. Upon comparing them with existing races, it is discovered that they are generally quite distinct; so that the fossil tribes, in some degree, appear like a separate creation, and have been elegantly termed 'organic remains of a former world.' But though different in detail, the ancient and existing races of organic nature are alike in generalities, and analogous in essential points of structure; and forcibly urge us to conclude that they were destined for similar modes of life. In the present economy of nature, plants of particular structure are appointed to exist under particular circumstances; shells of certain forms are peculiar to water, and others live habitually on land; and, generally, so constant is the agreement in the structure and functions of organic beings, that from the one we may infer the other. Who, that views the striking general resemblance of fossil and recent bodies, and considers the similar accidents to which both have been exposed, can hesitate for a moment to admit that conclusions drawn from examination of the structure of fossils, are as valid as those which are inferred from recent examples. The principle of investigation is in both cases the same, viz. the inevitable accordance between the construction of the creature, and the uses for which it was created.

"From examinations conducted on this principle, it is inferred that the secondary strata contain remains of marine, lacustrine, and terrestrial plants; of marine and fresh-water shells, crustacea, and fishes; and of aquatic and terrestrial reptiles, mammalia and birds. This simple statement furnishes ground for most interesting deductions respecting the ancient condition of the globe. We cannot, indeed, determine what was the comparative extent of its seas, lakes, and dry land; but we may form very reasonable opinions concerning its temperature, and a tolerable history of its inhabitants at different periods. For as the order of successive position among the rocks is likewise that of their relative antiquity, the fossils collected from these rocks may be arranged in chronological order.

"The fossils of Britain thus arranged, (according to the example of Mr. W. Smith,) present us with many curious and important results. The following instances are selected rather to show the richness and beauty of the subject, than to include all that is known respecting it.

"The organic reliquiæ of animals are more ancient than those of plants, for they lie in the slate rocks of Cornwall and North Wales, whilst no plants have yet been found in any rock older than the lower red sandstone. The most abundant fossil remains of plants belong to terrestrial tribes; but the animal reliquiæ are mostly of aquatic origin; and very few examples are known of any bones of terrestrial animals occurring in strata more ancient than those above the chalk.

"The most ancient animal remains are those of bivalve shells, (Spiriferæ,) such as are not known to exist at present. The most ancient fossil plants which appear in the lower carboniferous rocks, almost

almost wholly belong to terrestrial genera of the natural monocotyledonous orders, Filices, Lycopodiaceæ, and Equisetaceæ, and, by their analogy to existing tropical tribes, seem to demonstrate that the climate of these northern regions was then warmer than it is at present.

"The fossil plants of the middle æra, which accompany the lias and oolitic rocks in Yorkshire and Sutherland, belong chiefly to the natural monocotyledonous orders, Filices, Lycopodiaceæ, Equisetaceæ, and Cycadeæ, but fragments of dicotyledonous plants also occur with them.

"The least ancient group of fossil plants, which are enclosed in strata above the chalk, are a mingled suite of monocotyledonous and dicotyledonous tribes, both terrestrial and lacustrine, bearing considerable analogy to plants now in existence. The greater number of fossil shells are certainly marine, but those which lie in layers amidst the monocotyledonous plants of the carboniferous formation, belong almost wholly to fresh-water genera, now in existence. Other local aggregations of fresh-water shells occur in the upper part of the oolitic series of rocks; but a general deposit of this kind occurs among the most recent, and contains species very similar to those that now exist.

"The greater portion of the most ancient fossil shells, &c. belong to genera now extinct, as the Productæ, Spiriferæ, Pentameri, Orthoceratites, Trilobites, and many genera of Crinoidea; and on the other hand, the least ancient of the fossils, though specifically distinct from existing races, are mostly included in the same genera.

"But the most important results to geology, arising from the contemplation of organic remains, are founded on a minute scrutiny of their specific characters, and a careful register of their localities in the strata. It is not enough for the rigid accuracy of modern inquiry, to say that a given rock contains corals, shells, and bones of fishes; but we must know the particular species, and determine all the circumstances of their occurrence. The more exact and extended our researches on this subject become, the more clear will be our statements on the succession of created beings, the more certain our applications of zoological principles to determine the relative antiquity of rocks, and the more satisfactory our views of the formation of the strata. Works which, like the present, profess to describe the rocks and fossils of a particular district, lose a large portion of their utility if they are composed without reference to general principles. It is in such local catalogues that the man of enlarged views in geology ought to find the best evidence of important truths, and the means of correcting serious errors. For these important ends, it is necessary that every known locality in the strata should be recorded of every fossil. For want of this precaution, fossils have been often stated to be characteristic of a particular rock, when in truth they occur in several others; and thus a crowd of errors have been introduced, which have obscured the truths taught by Mr. Smith, and given occasion for denying that a comparison of their imbedded fossils is useful in identifying and discriminating the strata. Deeply impressed with the interest and importance

importance of this subject, I have sought the means of placing it in a clear and correct light; and am not without hopes, that whether my views be received or rejected, my statements will be found unprejudiced, and, though incomplete, correct.

"I shall now endeavour to investigate some of the general laws, respecting the relation of fossils to the strata, which are either already recognised and admitted among geologists, or unfolded in the following pages. The inquiry naturally divides itself into two parts, according as the strata are considered, with respect to their chemical and mineralogical composition, or their relative antiquity. Considering rocks as definite chemical compounds, (an assumption sufficiently exact in a limited district,) we may inquire if fossils of the same kind belong to strata of the same character.

"A decisive answer in the affirmative will suggest itself to him who observes the agreement in this respect, between the transition limestone and the mountain limestone, in their bivalve shells and trilobites, between this latter rock and the oolites in their Astreæ, Turbinoliæ, and Milleporæ, and between the oolites and the chalk, in some of their Echini and Terebratulæ. But this analogy vanishes altogether when we attempt to extend it to a considerable series of fossils; no other strata than the limestones exhibit it in a striking degree, and few tribes of organic remains can be quoted in illustration, except the Radiaria. On the contrary, the shells of the mountain limestone, oolite, and chalk, are all entirely distinct from one another, and immediately suggest the second inquiry, to which we now proceed. What is the relation between the species of fossils, and the antiquity of their enveloping strata? That such a connection between the age of a rock and its organic contents does certainly exist, and may plainly be recognised, will appear from a few facts which any one may verify by examining a good collection of Yorkshire fossils, or a sufficient suite of specimens from the same strata in other parts of England. The mountain limestone of the north-western dales of Yorkshire, abounds with Crinoidea, Productæ, Spiriferæ, and Bellerophontes, of which no single individual has ever been found in the strata of the eastern part of the county, which on the other hand, contain Echini, Trigoniæ, Cucullææ, Rostellariæ, and Ammonites, to which there is nothing similar in the west. The partition between these groups of strata and their fossils is made by the red sandstone stratum, which in Yorkshire at least has never yielded one single organic fossil. The same observation has been made in other parts of England. Again, in the eastern part of Yorkshire itself, a complete partition of the same kind is made by the blue clays of the vale of Pickering, between the chalk on the south and the oolitic rocks on the north; both full of fossils, and those entirely different.

"I am sure that these assertions will not be disputed by any person at all acquainted with geological phenomena, or accustomed to distinguish the characters of fossils. The consequence flowing from them is of the highest importance and interest; for since it thus appears, that a few shells brought from a quarry, are data sufficient to determine the geological relations of the rock, we are entitled

entitled to conclude, that in a given district the age and position of certain strata, or groups of strata, are infallibly indicated by their organic contents. These researches, commenced by Mr. Smith in England, have been extended with the same results over all parts of Europe, and a large portion of America, and therefore it is concluded that strata, or groups of strata, are to be discriminated in local regions, and identified in distant countries, by their imbedded organic remains.

"Having thus obtained the general principle, let us endeavour to ascertain the extent of its applicability, and the precautions necessary to ensure accurate results.

"So unequally are the different species of fossils distributed in the earth, that, whilst some are dispersed through several neighbouring strata, as Clypeus clunicularis among the oolitic rocks, others are confined to one stratum, as Ammonites calloviensis to the Kelloways rock, and some to a particular bed of stone, as the Astreæ which characterize the coralline oolite.

"It is therefore possible, by collecting numerous specimens procured from a limited district, to assign to each formation of strata, single stratum, or even characteristic bed of stone, all the fossils which have ever been discovered in it. Such catalogues being compared, formations, strata, and beds, may be found to differ from one another by the presence or absence of particular species. A given formation may possess species never found in any of those above, and it may be deficient in others which do occur above, and in like manner it may differ from those below. Hence it may be concluded,

"1. That a formation or stratum may differ from all those above it, by the presence or absence of certain species, and from all those below it, by the presence or absence of other species:

"2. That it may contain some particular species, unknown either above or below. We may add, that formations and strata may differ by the relative abundance or paucity of their imbedded fossils.

"EXAMPLES.

"1. The coralline oolite formation, as defined p. 32, appears to me to differ from all the formations above, by the presence of Ammonites perarmatus, Mya literata, and Clypeus clunicularis, and by the absence of Ostrea delta, hamites, and ananchytes; and from all those below, by the presence of Spatangus ovalis? and Ammonites perarmatus, and the absence of Productæ, Axini, Ammonites Walcottii, Nerita costata, Astarte minima, and Terebratula digona.

"2. Again, the Kelloways rock differs from all the strata above it and below it, by the presence of Ammonites calloviensis, and Gryphæa dilatata: no stratum in Yorkshire but the Kimmeridge clay contains Ostrea delta; nor is Gryphæa incurav found except in lias beds or lias boulders.

"3. It is in the lower part of the coralline oolite that Clypeus dimidiatus, and C. clunicularis abound, but Melania striata belongs to the upper layers of that rock.

"These are the principles of investigation which it is proposed to apply

apply to the strata and fossils of the eastern part of Yorkshire, and to illustrate by the aid of the arranged catalogues which follow, and their accompanying plates."

The detailed catalogues which follow contain a clear and systematic arrangement of all the fossils hitherto discovered in the several strata, with references to the plates of this or other works, and to the localities in Yorkshire and various other parts of England. Each catalogue is terminated by a compendium of geological inferences, and, where the subject allows, by a specific enumeration of the identifying or characteristic fossils*. As a specimen, we give the observations on the Kelloways rock: p. 142 and 143.

"The Kelloways rock, seldom exposed in a satisfactory manner in the South of England, and either deficient or concealed beneath the Oxford clay from Wiltshire northward to the Humber, would perhaps never have been recognised in Yorkshire, without attention to its highly characteristic fossils. In the winters of 1820 and 1821, Mr. Smith collected some specimens of Ammonites calloviensis, and A. Kœnigi, from the north cliff of Scarborough; which, the moment I saw them, convinced me that he had discovered the Kelloways rock in Yorkshire. Subsequent investigation, by proving that the rock which had furnished these 'silent witnesses,' occupied, relatively to other strata above and below it, exactly the place of the Kelloways stone, removed all doubt from Mr. Smith's mind, and enabled him to demonstrate that, amidst the acknowledged anomalies of the lower oolitic series on this coast, the lines of geological agreement may be securely drawn, to unite them with their type in the midland and southern counties. His inferences on the subject, like many other of his valuable observations, have now become the common property of geologists, without the intervention of any publication by himself, which might remind those who profit by his labours of the praise that is due to the disinterested liberality of his communications.

"Of sixty species enumerated above, one-half the number occur likewise in other strata on the coast of Yorkshire; twenty-six of these have been seen in the superior strata of the coralline oolite formation; twelve exist in inferior rocks which belong to the Bath oolitic series, and at least eight are diffused alike through the strata above and below it. These are dicotyledonous wood, Mya literata, Mya calceiformis, Trigonia clavellata, Modiola, Pecten lens, Perna quadrata, Turritella muricata. Of the thirty species which remain, future researches may prove a considerable portion to be characteristic of this remarkable rock; but at present I shall content myself with pointing out those which my own experience in Yorkshire has

* "It deserves attention," Mr. Phillips remarks, "that the interesting remains of *Spongiæ* are nowhere so well developed as in England, and perhaps nowhere in England so well as in Yorkshire. On the shore near Bridlington, they lie exposed in the cliffs and scars, and being seldom enclosed in flint, allow their organization to be studied with the greatest advantage."

taught

taught me to confide in, and which, therefore, it may be hoped, will not mislead others. These are the ammonites generally, but Ammonites calloviensis, and A. Kœnigi, especially, (for that which Mr. Sowerby figures from the lias in connection with the Kelloways fossil, appears to me quite distinct,) and the small variety of Gryphæa dilatata. These are the very fossils which Mr. Smith so long ago pointed out as proper to identify this rock in Wiltshire; and it is worth remarking, that every species figured on his plate as characteristic of the stratum in the southern counties, may, with suitable precaution, be employed for the like purpose in Yorkshire. This rock seems unknown beyond the British islands, and its fossils are not, I believe, described by any foreign geologist."

The subject of the imbedded organic remains is terminated by a very valuable and laborious catalogue of all the plants and animal remains hitherto discovered on this coast (505 species), arranged in families according to their natural affinities, and accompanied by references to *all the strata* in which they have been respectively discovered: pp. 167–176.

We have no room for further remarks. The history of Kirkdale Cave, having been already given in full by Dr. Buckland, is here condensed into two pages and a half; and a short chapter is added on the Basaltic Dyke, and on the economical Uses of the Mineral Productions of the Eastern part of Yorkshire. The following remarks respecting coal contain a moral of general application.

"Coal occurs extensively in the north-eastern part of Yorkshire, in the sandstone series between the gray limestone and the dogger, but always in thin seams, and generally of inferior quality. The immense advantages which would arise from the working of thick seams of good coal, sufficiently account for the many unsuccessful attempts to discover them. The opinions of *working colliers* on this point have too often been preferred to the legitimate deductions of science, and even yet persons will perhaps be found willing to credit the delusive tale of finding good coal by *going deeper*. But the warning must be given, though it be disregarded ; and from all the natural exhibitions on the coast, as well as from the result of every experiment inland, I am compelled to state, that any hope of discovering seams of coal more than eighteen inches or two feet in thickness, in any part of the strata *above* the upper lias or alum shale, is entirely unsupported by reason and experience. That the coal measures of Durham and western Yorkshire exist (covered by magnesian limestone and red sandstone) *beneath* the lias, is probable, but the practicability of reaching them by pits, even in Cleveland, or near York, is very questionable, and the expense of the experiment may be ruinous.

"Of several thin and variable seams of coal which appear among the sandstone rocks above the lias, only the lower one immediately above the dogger, and the upper one not far beneath the gray limestone, have been found worth the expense of working. The upper seam is the most regular, and has been worked at Cloughton Wyke, Maybecks, Goadland, Glaizedale, Danby, Blakehoe, Rudland, Coxwold, Newborough Park, Colton, &c.: that this and the lower seam

may

may be opened in new places, is highly probable, and such attempts may be productive of much local advantage, but they should be guided by *geological induction*, and not abandoned to *ignorance and empiricism.*"

In conclusion, the opinion to which we have arrived after the examination of this work, is that its publication has fully disclosed the geological structure and affinities of one of the most interesting and least understood natural districts in England; and we sincerely hope that the author will continue his illustrations of the science, so auspiciously begun.

LXVI. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

March 24.—A PAPER was read, entitled "Description of a Mountain Barometer, the column of which is divisible into two portions for safer and more convenient transport." By Mr. Thomas Charles Robinson. Communicated by Captain Henry Kater, F.R.S.

The object of the contrivance described in this paper is to reduce the length of the barometer, when not in use, to one-half the usual length; and to render the position in which it may be carried indifferent. It consists of a glass tube eighteen inches long, cemented into a steel cistern two inches long, and one inch internal diameter, which is furnished with an internal screw, for receiving a hardened steel screw and hemisphere cemented to the end of a syphon tube. The long leg of this tube has an internal diameter of only six or eight hundredths of an inch, and it is further contracted at the end to the twenty-fifth of an inch, so that no air can pass when the mercury is descending through it. The shorter leg of the syphon has the same bore as the tube.

When the two parts are screwed together, and the whole inverted, the mercury descends from the cistern, fills the long leg of the syphon, and ascends to a certain height in the shorter leg. Any air that may have existed in that part of the cistern which was not occupied by the mercury, is collected in an intermediate space, external to the column of mercury, and therefore can have no influence on the total height of that column, which is determined solely by the pressure of the external atmosphere. On gently reversing the position of the barometer, the mercury will re-pass from the syphon into the cistern, where it is confined by a stopper, as in a bottle: and may then be carried about in any position in perfect security.

The reading of a paper, entitled "An Account of further Experiments tried at Chatham, for the purpose of obtaining an artificial Water Cement," by Brevet-Colonel C. W. Pasley, of the Corps of Royal Engineers, F.R.S. and Honorary Member of the Institution of Civil Engineers, was commenced.

The Society then adjourned over Easter to the 14th of April.

April 14.—Colonel Pasley's paper was resumed and concluded.

The present paper is occupied with the detail of the experiments made by the author in the prosecution of the object of his former inquiry, already submitted to the Royal Society, into the best means of obtaining an artificial Water Cement. These experiments were tried on a larger scale than the former, and were applied more especially to the practical purposes of building. He recommends that the cement should not be applied in two coats, the surfaces being less likely to adhere when this is done, than if the whole cement is applied at once. He succeeded in various ways, in forming cements which appeared to be the same, in all their properties, with natural cements: and he has now employed them in buildings on a scale sufficiently extensive, and in situations sufficiently exposed to the weather, to be brought to the test of experience in the course of time. Some experiments were also made by the author, with the view of forming an artificial lithographic stone, by a calcined mixture of chalk and carbonate of magnesia: but their density could not be rendered such as to answer the purpose intended.

On the whole he draws the general conclusion, that in all attempts to imitate the water cements of nature by artificial means, carbonate of lime must be the essential ingredient; next to which in point of importance are silica and alumina. The author succeeded in forming a very good cement by uniting these three ingredients. By the addition of a small proportion either of the protoxide of iron or of the oxides of lead, or of manganese, the qualities of the compound were very much improved; these latter ingredients appearing to produce a more intimate union of all of them, and a more speedy and permanent induration of the mass.

A paper was read, "On the Meteorological Observations made at the Apartments of the Royal Society, during the Years 1827, 1828, and 1829." By J. W. Lubbock, Esq. V.P. and Treasurer of the Royal Society.

The author first inquires into the annual and diurnal variations of the barometer and thermometer, for the determination of which he takes the mean of the observations in each month made at the Apartments of the Royal Society, during the years 1827, 1828, and 1829; and also that deduced from M. Bouvard's observations, published in the Memoirs of the French Academy of Sciences. From the table given it would appear that the annual variations are independent of the diurnal variations. A much greater number of observations than we possess at present, made frequently and at stated times each day, are requisite before any very satisfactory conclusion can be deduced as to the influence of the moon on the fluctuations of the barometer. The author, however, has attempted the inquiry, as far as the limited range of the present records will allow, by classifying all the observed heights, corresponding to a particular age of the moon, as defined by her transit taking place within a given half hour of the day; and thence deducing mean results, which are exhibited in tables.

The results afforded by the observations at Somerset House differ widely from those obtained from corresponding observations made

made at the Paris Observatory. According to the former, the barometer is highest at new and full moons, and lowest at the quadratures, the extent of the fluctuations being 0.08 of an inch: according to the latter, the contrary is the case, and the extent is only 0.05 of an inch.

Lastly, the author endeavours to ascertain how far the barometer is affected by the direction of the wind, and gives, in the form of tables, the mean results of observations bearing upon this point. The fluctuation, he observes, due to this, is much greater than that due to any other cause. The barometer is lowest, as might be expected, when the wind is in the rainy quarters of S.W. and W.S.W. There are not yet sufficient data for any general conclusions with regard to the influence of electrical phænomena on the weather.

April 21.—A paper was read, "On the Errors in the Course of Vessels occasioned by Local Attraction, with some remarks on the recent loss of His Majesty's ship Thetis." By Peter Barlow, Esq. F.R.S., &c.

The author observes that the errors arising from the deviation of the compass produced by the attraction of ships, were formerly much less considerable than at present, from the comparatively small quantity of iron existing in the vessel. The increase of this disturbing force in a modern ship of war is easily accounted for by the immense proportion of iron now employed in its construction, by the use of iron ballast and iron tanks, of iron knees, iron cables, and above all, of iron capstans, besides various other articles made of the same material, forming altogether a very large and powerful magnetic mass.

The direction and intensity of the deflecting forces thus produced, vary in different latitudes and on different sides of the equator; being greatest in the highest latitudes, where the dip is considerable, and when the ship's course is east or west: and in high southern latitudes, being the reverse of what it is in high northern latitudes. In His Majesty's ship Gloucester, which may be taken as an example, the deviation of the compass in the east and west points was found to be, in the British Channel, 9° 30′: so that after running ten miles, the vessel would be more than a mile and a half to the southward of her reckoning, and so on in proportion as the distances increased. An error of this magnitude, occurring in a narrow channel and in a dark night, were it unknown or disregarded, might lead to the most fatal consequences; and the disaster might perhaps be erroneously ascribed to the prevalence of a powerful current, the existence of which was before unknown.

The Thetis sailed from Rio Janeiro, in December last, with a million of dollars on board, in the finest weather, directing her course to the S.E. The next day, thinking they were clear of land, they tacked, and were sailing at the rate of nine knots, when the first intimation they had of being near land, was the striking of the jib-boom against a high perpendicular cliff, which broke the bowsprit short off, and sent all three masts over the side; thus in a moment bringing utter destruction on this fine vessel and her valuable cargo.

cargo. The author shows that the deviation of the compass arising from the attraction of the vessel, was exactly of the kind which was likely to occasion this great mistake in the ship's reckoning: for the distance run by the Thetis being about eighty miles, if the local attraction of the vessel had been equal to that of the Gloucester, she would have passed five miles nearer to Cape Frio than her reckoning,—an error quite sufficient to account for the fatal catastrophe. The author hence infers the importance of bestowing more attention than has hitherto been given to the influence of the local attraction of vessels, and to the application of the proper means of correction.

April 28.—A paper was read, "On the Anatomy and Physiology of the Minute and Capillary Vessels." By Marshall Hall, M.D.

The author, considering the minute blood-vessels as *arteries* or *veins*, as long as their subdivisions or junctions are attended with a change in their dimensions, denominates them *capillaries* when no such change occurs. With the aid of an achromatic microscope of Dollond's, he endeavoured to ascertain what differences existed between the systemic and pulmonary circulations, as far as regards these vessels. Dr. Edwards had observed that the batrachian reptiles are speedily killed by immersion in hot water: and the author found that although by plunging any of the animals of that order into water at 120° of Fahrenheit they are speedily deprived of all power of sensation and of motion, yet the action of the heart continues for a very long time, thus affording an opportunity of leisurely observing the phænomena of the circulation, without the infliction of pain, and without any disturbance from the struggles of the animal.

In the fins and tail of the stickleback, the number of the capillary vessels is small, and their distribution simple: the artery runs along the border of each ray till it reaches the extremity, when it is reflected, and becoming a vein, pursues a retrograde course by the side of the artery. This simplicity in the mode of its distribution corresponds with the simple nature of the function of the part, which is merely an instrument for swimming. In the web of the frog's foot, which is adapted to a greater variety of mechanical purposes, the system of blood-vessels is somewhat more complex; the capillaries are more abundant; the arteries, which are nearly equal in number to the veins, pursue a more direct course; and the veins are larger and more tortuous. No pulsatory movement can be perceived in the blood while moving in the capillaries or veins, as long as the circulation is unimpeded and in the natural state. The author was unable to detect any anastomoses between the minute arteries, although they are frequent among the veins, where they give rise to occasional oscillations in the currents of blood flowing through them: neither could he discover any instance, in the web of the frog, of the immediate termination of an artery in a vein. The velocity of the blood is retarded immediately in its passage from the arteries into the capillaries, because the united capacity of the branches is greater than that of the trunk which divides to form them. In the mesentery of the toad, the distribution

tion of the vessels is simple, like that of the fins and tail of a fish. But in the pulmonary organs, where the purpose to be answered is that of diffusing the blood over the greatest possible extent of surface, the arteries and the veins correspond to each other in all their ramifications, and their adjacent branches generally pursue courses parallel to each other. Their transition into capillaries is effected with fewer subdivisions than in the case of other arteries. No disposition exists among these arteries to form anastomoses with each other, or with the veins; but the intervening spaces are uniformly occupied by a close network of capillary vessels. The lung of the salamander is simply vesicular; that of the frog is cellular, as well as vesicular, and consequently presents greater difficulty in following with the microscope the course of the vessels as they traverse membranes situated in different planes. In the lungs of the frog, the larger vessels pass chiefly on the external surface; but in the toad they follow the course of the internal margins of the vertical meshes. The author concludes from his observations, that the capillaries, properly so called, have no power to contribute to the motion of the blood, and that the capillary circulation depends altogether upon the action of the heart and arteries. In cases of impeded circulation, he observes, the pulsatory movement of the blood may be seen, not only in the arteries, but also in the capillary vessels, and even in the veins.

At nine o'clock, pursuant to the Notice sent to the Fellows, according to the Statutes, a ballot was taken for filling three vacancies in the Council, occasioned by the resignation of Viscount Melville, K.T., Sir George Murray, G.C.B., and Sir Robert Peel, Bart. Dr. Goodenough and Sir Robert Inglis were appointed scrutators. After examining the Balloting Lists, they reported that John Frederick Daniell, George Dollond, and Charles König, Esqrs., were elected Members of the Council.

A Letter from Sir James South to the Treasurer was read, stating, that the Dome of the Building intended for his large Equatorial was nearly completed, and that he would be happy to show it to the Members of the Society any day of the week, between the hours of one and five.

GEOLOGICAL SOCIETY.

April 13.—A paper was read, dated at Sydney, New South Wales, 14th October, 1830, and entitled, "An Account of the limestone caves at Wellington Valley, and of the situation, near one of them, where fossil bones have been found:" by Major Thomas L. Mitchell, F.G.S., &c. Surveyor-General of New South Wales.

Wellington Valley is about 170 miles west of Newcastle on the eastern coast of Australia. It forms the ravine of the river Bell, one of the principal sources of the Macquarrie, which river it joins, after a course, below the places described in the paper, of about six miles in a direct line from south to north; the Macquarrie itself at the point of junction running nearly from east to west, in its progress towards the swamps of the interior, where it disappears.

The

The rock, through which the valley has been excavated, is limestone, much resembling in external characters that of the carboniferous series of Europe. This appears on both sides of the valley above the alluvial deposits in the bottom, and extends on the east to the height of about 100 feet above the stream. On the west of the valley, hills of greater height run parallel to the limestone, consisting of a red sandstone and conglomerate; and a range of heights on the east of it is composed of trap rocks. The basis of a tract, still further eastward, which divides the watershed of the interior, from that which sends its streams to the sea, is granite.

The rugged surface of the limestone tract, in several parts of which the bare rocks are exposed, appears to abound in cavities, the orifices of caves and fissures; two of which, the more immediate subject of this communication, are about eighty feet above the stream of the Bell, on its eastern side; the first being a cave about 300 feet in extent; the second apparently a wide fissure in the limestone, partially filled up.

The Cave agrees in structure with many of those well known from the descriptions of Dr. Buckland and other writers: it descends, at first, with a moderate inclination; and about 125 feet from the mouth, the floor is thickly covered with a fine dry reddish dust, in which a few fragments of bones, apparently of kangaroos, occur. The cavern in different places affords beautiful stalactites and stalagmitic incrustations. Irregular cavities in the roof seem to lead towards the surface of the hill; and at the remotest part the floor is covered with a heap of dry white dust, so loose and light, that one of the exploring party sunk into it up to the waist. This dust, when chemically examined by Dr. Turner, was found to consist principally of carbonate of lime, with some phosphate of lime and animal matter. In fine, the cave appeared to terminate in a fissure nearly vertical, with water at its bottom, about thirty feet below the lowest part of the cavern, and nearly on a level with the waters of the river Bell. This fissure also extended upwards towards the surface.

About eighty feet to the west of the cave above described, is the mouth of another cavity of a different description, first examined by Mr. Rankin. At this place the surface itself consists of a breccia full of fragments of bones; and a similar compound confusedly mixed with large rude blocks of limestone, forms the sides of the cavity, which is a nearly vertical, wide, and irregular sort of well, accessible only by the aid of ladders and ropes. This breccia consists of an earthy red calcareous stone having small fragments of the grey limestone of the valley dispersed through it, and in some parts possesses considerable hardness. Near the lower part of the fissure (the whole extent of which was not explored) were three layers of stalagmitic concretion about two inches in thickness and three inches apart, the spaces being occupied with a red ochraceous matter, with bones in abundance imbedded both in stalagmite and between the layers of it.

The bones found in the fissure just described, of which specimens have been sent to England, belong with only two exceptions, to animals at present known to exist in the adjacent country; and their dimensions

dimensions also are very nearly the same with those of the existing quadrupeds. The species, from the report of Mr. Clift, to whose examination the bones were submitted, appear to be as follows: Kangaroo, Wombat, Dasyurus, Koala, Phalangista,—the most abundant being those of the Kangaroo. Along with the remains just mentioned were found two bones, not agreeing with those of any of the animals at present known to exist in New South Wales. The first and larger (of which a figure only accompanies this paper, the bone itself having been sent to Edinburgh) is supposed to belong to the Elephant: the second bone is also obscure and imperfect, but seems to be a part of one of the superior maxillary bones of an animal resembling the Dugong; it contains a portion of a straight tusk pointing directly forward.

A pit was dug, by Major Mitchell's direction, in the surface of the ground about twenty-five feet from the mouth of the fissure, at a place where no rocks projected; and the hill was there found to be composed of a hard and compact breccia, such as that described above, and abounding likewise in organic remains.

Other caverns containing a similar breccia occur in the limestone on the north bank of the Macquarrie, eight miles north-east of those at Wellington; and about fifty miles to the south-east, at Buree, are several caves like the first described above, which communicate with fissures partially occupied with breccia containing bones. At Molong, thirty-six miles to the east of Wellington, a small quantity of concreted matter has been found, containing numerous bones, of which no specimens have been sent to Europe; but the author remarks that, from their size, they would appear to have belonged to species larger than those which at present occupy the country.

In conclusion, the author states that he can offer no explanation of the facts he has mentioned; and he points to the great resemblance between the bony breccia of New South Wales, and that of the shores of the Mediterranean described by Major Imrie, in the Transactions of the Royal Society of Edinburgh.

April 27.—A Paper was read, entitled, "On some effects of the atmosphere in wasting the surfaces of buildings and rocks:" by John Phillips, F.G.S., &c.

The remarks in this paper are restricted to the initial or preparatory processes by which earthy materials are provided for rivers and the sea to transport and deposit in new situations. These processes are considered by the author under several heads, according to their chemical and mechanical relations; but he observes that it is not always possible to distinguish accurately the effects of these several causes, which indeed are commonly concerned in the same operation.

The author, after stating some of the changes produced upon various rocks and buildings by the chemical agency of the gaseous elements of the atmosphere, illustrates the almost entire immunity from such alterations enjoyed by substances buried in the dry earth, by the remarkable perfection of sculpture, colour, and gilding, of the statues formerly

formerly placed in St. Mary's Abbey at York, which were recently discovered in digging the foundation of the Yorkshire Museum.

The more rapid waste of those parts of a building which are shaded by a projecting ledge, is compared with analogous effects upon detached blocks of stone (like the Buckstone near Monmouth), which by a further continuation of the process might be transformed into rocking-stones, as at Brimham Crags in Yorkshire. The rapid waste occasioned by fluctuations of heat and moisture is next examined; and it is shown that the south and west fronts of buildings suffer most by these variations; that when the composition of the stone is unequal, the waste of its surface corresponds in general to the nature and arrangement of the particles; but that also there are cases when the atmospheric influences cause an exfoliation of the surface, without reference to the internal arrangement of the particles. Thus, desquamation is observed to happen parallel to the ornamented surface of the sandstone balusters of a bridge at Durham, to the rounded face of the "flagstone" employed for curbstones at York, to the embossed tooling of the "molasse" used in the walls of Zurich, and to the west front of the magnesian limestone of a church in Yorkshire.

The power of frost in connection with other agents is then noticed as very important in producing the fall of mountain precipices; and the author concludes his paper with a description of some remarkable excavating effects of rain on the surfaces of ancient monumental stones and bare limestone rocks. He endeavours "to show, that within the historic æra hard and durable stones have been greatly furrowed by the rain, and that in more ancient periods the precipitaions from above have carved themselves channels of various kinds, and sometimes occasioned real though miniature valleys of great length and continuity."

The first example of these rain channels is taken from the druidical stones of Boroughbridge, composed of millstone grit, called the Devil's Arrows; and it is shown that the rain beating upon these venerable pillars, has cleft their tops and furrowed their sides, in the lines of quickest descent, without regard to the irregularities of their composition. One of the stones leans remarkably and threatens to fall; but an examination of the rain channels shows the inclination of the stone to be of most ancient date, for these descend further on the upper sloping face than on the under.

Stones which have fallen from the limestone cliffs of Switzerland have been furrowed by the rain since the time of their descent.

On Doward Hill near Monmouth, and still more in the broad surface of the crags around Ingleborough in Yorkshire, the effects of the rain on the weathered beds of limestone are evident and remarkable. But the most striking phænomena of the kind known to the author occur on Hutton roof crags near Kirby Lonsdale.

Hutton Roof Crags afford an opportunity of tracing the rain channels over an immense surface of bare limestone rocks, lying nearly level on the hill-top, but sloping rapidly down the sides to the east and south. On the level top of the hill the stones are variously worn

worn in hollows and grooves, irregularly united and running in different directions, according to little inequalities of the ground; but on the steep slopes the channels are extended into long furrows, which, meeting at acute angles, enlarge, widen, and descend the hill-side in lines following exactly the declination of the rocks, and stopped only by the few and distant fissures, beyond which other systems of concurrent grooves begin.

ZOOLOGICAL SOCIETY.

March 22, 1831. Joshua Brookes, Esq. in the Chair.

The Report on the animals for the importation of which the Council should be recommended to take measures, was again brought under the consideration of the Committee, and was adopted.

A Report from Mr. Miller, the Superintendent of the Society's Gardens, was read, explanatory of the circumstances attending the birth of the *Armadillos*. On the morning of the 1st February it was discovered that the female had made a nest of straw, close up to the pipe that conveys the warm water round the building, and had brought forth two young, which were quite blind, and measured about four inches from the head to the tail. The male was immediately removed to another cage, but it was supposed that he had injured one of the young ones on the head before they were discovered, of which hurt it died on the following morning. At that time the other young one seemed to be perfectly well, and was sucking; but it also was found dead on the morning of the 3rd of February. It was bitten on several parts of the head by the mother. It is probable that the injuries were inflicted by her in consequence of her young ones having been moved about; and measures have been adopted to prevent the recurrence of such disturbance on any future occasion.

The following notes on the *Ctenodactylus Massonii*, Gray, were read by Mr. Yarrell:—

"The death of two examples of an interesting little animal from Barbary, very similar to the *Lemmings* in external appearance, has enabled me to place before the Committee some particulars of structure and anatomy which possess considerable novelty. The subjects themselves were presented to the Society by Hanmer Warrington, Esq., British Consul at Tripoli, a Corresponding Member of this Society, and one of its most liberal donors.

"From two preserved skins of the same species, in the collection at the British Museum, Mr. Gray, in his 'Spicilegia Zoologica,' has lately published an account of this animal, under the name of *Ctenodactylus Massonii*. These specimens were received from the Cape of Good Hope, and were considered new to science. There is reason however to believe, as suggested by Mr. Ogilby, that all the four specimens may be considered identical with the *Mus Gundi* of Rothman, on whose description is founded the *Arctomys Gundi* of Gmelin and other writers, and the *Gundi Marmot* of Pennant's Zoology, vol. ii. p. 137: Rothman's short description coincides with the animal in question, and he states that his species inhabits Barbary, towards Mount Atlas, near Massufin.

" The resources of the Society furnish the following additional particulars :—

" The length of the animal from the nose to the origin of the tail is eight inches ; of the tail itself, one inch. The general external resemblance to the well-known *Lemmings* has been noticed, but these examples have but four toes on each foot, with one small naked pad under each toe : the two middle toes are the longest and equal, the outer toe the shortest, the inner toe intermediate in length, and on the hind feet of remarkable structure.

" Immediately above a short curved nail there is a transverse row of horny points forming a pectinated apparatus ; above this is a second parallel row of stiff white bristles ; and over this, a third row of bristles, which are much longer and more flexible : there are thus three distinct parallel rows of points of unequal firmness. The toe next the inner one has two small fleshy tubercles above the nail, covered by two rows of bristles, the under one short, the upper long ; it has no horny points. The two outer toes, without tubercles, have each only one tuft of long bristles.

" With this described comb-like instrument on the inner toe only of each hind foot, the little animals were observed to be continually dressing their soft light brown fur ; and the facility with which they managed to reach every part of each lateral half with the toe of the foot on that side, as well as the rapidity of the motion, were very remarkable.

" When walking, the whole length of the hinder foot, from toe to heel, was placed upon the ground ; of the anterior extremity the toes only rested on the ground.

" When deprived of the skin, the head appears large compared to the bulk of the body ; it is wide and flattened in form : the *meatus auditorius externus* is elongated, forming a tube 2-10ths of an inch in length on the inferior surface, and lined with a dense black pigment. No cheek pouches exist. The teeth are of singular character, the molars of the upper and under jaws being decidedly different. Incisors $\frac{2}{2}$, canine $\frac{0}{0}$, molars $\frac{3-3}{3-3}$. The incisors of the upper jaw are stout, square and truncated ; the molars are oblong, flat and plain on the inside, with one indentation on the outerside. The incisors of the lower jaw are slender and pointed ; the molars somewhat diamond or lozenge-shaped, with one indentation between each of the four angles. This character more particularly applies to the two anterior molar teeth of each jaw, the last molar tooth, both above and below, being more elongated. From the superior incisors to the molars, the roof of the mouth presented four prominent tubercles anterior to the usual rough expanse of the palate. The *pharynx* and *œsophagus* were narrow. The lungs were made up of one large and two small lobes on each side ; the heart presented nothing remarkable. The liver paler than natural, soft, and granulated in appearance, was composed of two small and one large lobe on the right side, and two equal-sized lobes on the left : the gall-bladder large and spherical. The spleen measured 1 inch and 7-10ths in length, and 6-10ths in width.

width. The stomach, a single cavity, without any apparent division, measured 1 inch and 2-10ths in depth, in the direction of the entrance of the *œsophagus*, and 2 inches in breadth: the pyloric orifice contracted, the *duodenum* dilated to 1 inch and 2-10ths in circumference: length of the small intestines 2 feet and 9 inches. The *cæcum* 3 inches in length, curved upon itself, 2 inches and 4-10ths in circumference, and divided by numerous *septa*. The *colon* equally large at the commencement, but gradually diminishing: at the distance of 7 inches from the insertion of the *ileum* it was of small calibre, occasionally dilated, forming *sacculi*, in which the fæcal matter was collected and detained. The *rectum* narrow and uniform in size; the whole length of *colon* and *rectum* 3 feet 8 inches. The kidney of the right side was two-thirds of its length in advance of that on the left: each measured 7-10ths of an inch in its longest diameter, and 4-10ths in width.

"Some peculiarities observed in these little animals are worthy of notice. The molar teeth, as before stated, presented the singular anomaly of those of the upper jaw being different in their structure and surfaces from those of the lower jaw. The former, in their crowns, are very similar to those figured by M. F. Cuvier, as peculiar to his genus *Helamys* (*Pedetes*, Illig.); while those of the lower jaw somewhat resemble the teeth of the various species of *Arvicola*. The stomach, in form and pyloric contraction, is like the same organ in the *Lemmings* (*Lemmus*), *Jerboas* (*Dipus*), and *Gerbilles* (*Gerbillus*). The *cæcum* resembles that of the *Guinea-Pig* (*Cobaya*), *Agouti* (*Dasyprocta*), and *Marmot* (*Arctomys*); while the sacculated form of the *colon* is found in the common *House-Rat* (*Mus decumanus*, Linn.)

"Both the specimens possessed by the Society proved to be females. The skin of one has been preserved for the Museum: the bones of the other are in preparation for a skeleton, and when mounted may probably be the subject of further notice."

Mr. Yarrell having concluded the reading of his notes, it was stated by Mr. Ogilby, that since the time when he had originally mentioned his belief of the identity of the *Ctenodactylus Massonii* with the *Gundi Marmot*, that opinion had been confirmed by a passage in Captain Lyon's Travels in Northern Africa, in which the *Gundi* is so well described, as to leave no doubt on his mind of its being the same animal as those presented to the Society by Mr. Warrington.

Mr. Gray remarked, that the individuals of the *Ctenodactylus Massonii* which he had described, having been sent from the Cape of Good Hope, he did not suspect their specific identity with an animal from Barbary, known to science by short and imperfect notes alone, and of which no specimen was recorded as existing in any collection. He added, that the size mentioned by Rothman, that of a small rabbit, appeared to him to be greater than should be attributed to the animal in question; which, moreover, he could not regard as being of a testaceous red colour. In the other particulars mentioned in Rothman's brief description, his *Mus Gundi* agreed well with the *Ctenodactylus Massonii*.

 A spe-

A specimen was exhibited of the *Otis Kori*, Burch., which forms part of the collection of Mr. Gould. This gigantic species of *Bustard*, the largest yet known of its genus, measures upwards of five feet in height. No figure of it has yet appeared, nor is it described in any of the general works on ornithology; but its characters will be found, together with some other particulars respecting it, in Mr. Burchell's Travels in Southern Africa, vol. i. p. 393.

The following notes on the anatomy of a male *Suricate* were read by Mr. Owen:—

"Since I had the honour to lay before the Committee an account of the anatomy of the female *Suricate*, her male companion, the only surviving specimen which the Society possessed of this interesting species, has also died. This circumstance, otherwise to be regretted, has enabled me to add the following particulars to that account.

"The *rugæ* of the *œsophagus* are longitudinal throughout the whole length of the tube;—in the *Lion*, and some others of the Feline genus, the *rugæ* are transverse at the lower or terminal half of the *œsophagus*;—the cuticular lining is continued about two lines into the cavity of the stomach, where it terminates by a well-defined edge. This *viscus*, which was found moderately distended, presented no *rugæ* on the inner aspect, but was lined by a simply villous membrane, to which layers of coagulated *mucus* adhered very firmly. The muscular coat was thicker, as is usual, at the *pylorus*: this aperture was very small, not more than a line in diameter. An inch beyond this part the biliary and hepatic ducts entered by a common orifice. The interior of the small intestines presented a finely villous surface; and in the *ileum* were five patches of *glandulæ aggregatæ*, about half an inch in diameter, with intervals of four or five inches: the largest of these patches was situated at the termination of the *ileum*. The *apex* of the *cæcum* was occupied by a similar glandular structure. The terminal orifice of the *ileum* was of a circular form, about two lines in diameter, with a tumid margin, but unprovided with a valvular structure. In the lining membrane of the short tract of large intestines, *villi* were not perceptible to the naked eye. The verge of the *anus* was covered by the apertures of numerous follicular glands.

"The disposition and admeasurements of the alimentary canal corresponded with those of the female previously given. The spleen was one-third smaller; the *pancreas* had the same peculiar form, resembling the neutral symbol of the entomologist ♀. The liver had the same minutely mottled aspect which was observed in the female; but on employing the test of injection, the vascularity of the small bodies, which might have been mistaken for tubercles, became immediately evident, proving them to be the *acini* of the liver, remarkably distinct in this animal. The inner surface of the gall-bladder and its duct was villous, but without *rugæ* or valvular structure. The tubular structure of the kidneys terminates in a single pointed *papilla*: the ureters communicate, and end by a common orifice at the middle of the posterior surface of the bladder.

"The *testes* were about the size of horse-beans, and lay upon the *pubes*; the integument covering them had not any distinct appearance of

of *scrotum*. The extremities of the *epididymis* or *globi* were proportionately large. The *vas deferens* had a blind process on each side. The urinary bladder was contracted, and its coats consequently were thick: the membranous portion of the *urethra* was one inch and a half long, and its canal wide. The prostatic glands, analogous in their situation to Cowper's, were two in number, and as large as the *testes*; each terminated by a single wide duct, a few lines from the extremity of the *glans*. An interesting provision exists to prevent the secretions of these glands being driven into the large extent of *urethra*, which lies between them and the bladder: the inner membrane of the canal is raised in a semilunar fold behind the entrance of the ducts, which must act as a very complete valve during the turgescent state of the *parietes* of the canal. The *penis* is about eight lines in length; the *glans* of a pointed form, unarmed, the external orifice a longitudinal groove directed backwards.

"Both animals died with the pupil expanded, and of a circular form."

A description of the *Chiru Antelope*, by B. H. Hodgson, Esq., dated Valley of Nepal, Oct. 18, 1830, was read.—This animal, the supposed Unicorn of the Bhotians, was first described imperfectly by Dr. Abel, from an injured skin, and the notes of Mr. Hodgson. Dr. Abel gave to it the name of *Antilope Hodgsonii*; and it has subsequently been mentioned by M. Lesson as the *Ant. Chiru*, and by Major Hamilton Smith as the *Ant. Kemas?* Opportunities which have occurred since his original notes were prepared have enabled Mr. Hodgson to make some additional observations on other individuals, the results of which are given in the present paper. The species may be characterized as follows:—

Ant. Hodgsonii, Abel. *Ant. cornubus longissimis, compressis, gradatim attenuatis, suberectis, lyratis, annulis 15–20 anticè prominentibus, apicibus tantùm lævibus: vellere duplici; interno lanato cinerascenti-cœruleo; externo piloso supernè cervino, infernè albo: tumore molli utrinque supra nares.*

Fœm. *simillima?*

Longitudo circà 5 ped.; alt. ad humeros $2\frac{1}{2}$—3 ped.

In form the *Chiru Antelope* approaches the *Deer*. Its limbs are long and slender, but not weak: its neck is also rather elongated and slender: its head tapers forwards, but is somewhat deficient in elegance on account of the nasal tufts, and of a rather unusual quantity of hair and bristles about the mouth and nose. In its ordinary attitude the line of the back is nearly horizontal; the neck is bowed outwards and downwards, so that the head is carried not much above the level of the back; and there is a stoop in the hind legs on account of which, though they are rather longer than the fore legs, the hind quarters are not perceptibly raised.

The ears and tail are moderate, and devoid of any peculiarity; so likewise are the suborbital sinuses. The horns are exceedingly long, measuring in some individuals nearly two feet and a half. They are placed very forward on the head, and may be popularly said

said to be erect and straight, although properly speaking they bend forwards and outwards, and become suddenly incurved towards their tips. These latter are rather acute, and the horns near them become round; below they are laterally compressed, and are marked by a series of from fifteen to twenty rings, extending from the base to within six inches of the tip. On the lateral and dorsal surfaces of the horn these rings are little elevated, and present a wavy rather than a ridged appearance; but on the frontal surface they exhibit a succession of heavy, large ridges, with furrows between.

Close to the outer margin of either nostril is a soft, fleshy, or rather skinny, tumour or tuft, about the size and shape of the half of a domestic fowl's egg. These tufts, the purpose of which Mr. Hodgson has been unable to discover, appear to be peculiar to the *Chiru*.

In its double covering the *Chiru* agrees with all the hairy animals of Tibet; where not merely the goats and sheep, but the dogs, horses, and kine, possess an under fleece of soft and fine wool. The hair forming the external coat is about two inches long, and so closely set as to present to the touch an impression of solidity; it is straight, nearly erect, rather harsh, and feeble, being for the most part hollow like a quill. Gray-blue is the general colour of the hair throughout nine-tenths of its extent from root to tip, as well as exclusively so of the wool beneath the hair. This radical and prevalent colour is, however, but dimly seen through the external or superficial hues with which it is overlaid; hues which on the upper parts of the animal are fawn-red, and on its under surface and the inside of its limbs are white. The shoulders are faintly marked by a tracing of colour lighter than that of the surrounding parts. Down the front of all the legs runs a black line reaching to the hoofs on the fore legs, but to the knees only on the hind legs. The forehead is perfectly black, and a fringe of the same hue proceeding from the bottom of the frontal skin passes round the outsides of the nasal tufts. These tufts, as well as the rim surrounding them, are black; as are also the bristles of the mouth and lips; the few hairs, however, which depend from the lower lip are white.

Some of the dimensions of the fully grown young male from which the preceding description was taken are as follow: Entire length, 4 feet 11 inches; length, minus tail, 4 feet $2\frac{1}{2}$ inches; length, minus head and tail, 3 feet $6\frac{1}{2}$ inches; height at the shoulder, 2 feet 8 inches; height of the fore-leg, 1 foot 8 inches; of the hinder leg, 1 foot 9 inches; length of the horns, 2 feet $\frac{1}{2}$ inch; basal depth of the horns, fore and aft, $2\frac{1}{8}$ inches, from side to side, $1\frac{1}{4}$ inch.

The *Chiru Antelope* is highly gregarious, being usually found in herds of several scores and even hundreds. It is extremely wild and unapproachable by man, to avoid whom it relies chiefly on its wariness and speed; but though shy it is not timid, for if overtaken it meets danger with a gallant bearing. The individual which was kept alive at the Residency, though captured very young, was perfectly fearless, and could only be approached with caution. It is

is said by some to inhabit the plains of Tibet generally; while, according to others, it is confined to those plains which are within sight of mountains, especially of the Hemâchal mountains. It cannot bear even the moderate heats of the valley of Nêpâl; an individual belonging to the Lama of Digurchee, having died at the commencement of the hot season, when the maximum of temperature was only 80°, a temperature seldom reached for two hours a day or for two days of that month, March.

The *Chiru* is extremely addicted to the use of salt in the summer months, when vast herds are often seen at some of the rock-salt-beds which so much abound in Tibet. They are said to advance under the conduct of a leader, and to post sentinels around the beds before they attempt to feed.

To complete this abstract of Mr. Hodgson's account of the *Chiru*, it may be added, that at the following meeting of the Committee there was exhibited a drawing of its head and horns, which had been subsequently transmitted by that gentleman; together with a duplicate of his paper, to which he had added that he had recently seen a very old male, in which the dark parts had become grizzled and almost white.

Mr. Vigors recalled the attention of the Committee to the subject of the Himalayan Birds; confining his observations this evening to some species of the family of *Merulidæ* or *Thrushes.* Among these was a new species closely allied to the common European *Blackbird*, exhibiting the yellow bill and general black plumage of that bird, but differing from it in the varied markings of the wing. It was characterized as follows.

Turdus pœcilopterus. Mas. *Turd. corpore nigro, abdomine imo subcinerascenti-fusco; remigum mediarum pogoniis externis pteromatibusque cineraceo-griseis, his apice albis; rostro pedibusque flavis.*

Fœm.? *Corpore suprà brunnescenti-griseo, subtùs pallidiori; pteromatibus remigumque mediarum pogoniis externis ut in mari notatis, sed colore subrufescenti tinctis.*

Statura ferè *Turdi Merulæ*, Linn.

A species of *Cinclus* was exhibited, differing from the European in the uniform colouring of the plumage. Mr. Vigors expressed his opinion that it was the same species as that discovered in the Crimea by Pallas, and described by M. Temminck in his 'Manuel' as having "tout le plumage, sans exception, d'une seule nuance brune, couleur de chocolat."

The following may be given as its specific character.

Cinclus Pallasii, Temm. *Cincl. unicolor, intensè brunneus; rostro pedibusque fuscis.*

Statura *Cincli aquatici*, Bechst.

Mr. Vigors referring to the bird which had been described by the Prince of Musignano among the species from the Rocky Mountains, added to his Synopsis of North American Birds in the 'Annals of the Lyceum of New York,' (p. 439, sp. 94 bis), and which was conjectured by that distinguished naturalist to be the same as the *Cinclus*

Cinclus Pallasii, stated that upon comparing the original specimen, so described by the Prince, with the present bird, he found them perfectly distinct. The American bird is of a deep ashen gray colour, the Himalayan of a chocolate brown;—the bill of the former is yellow with a dark *apex*, and the legs are yellow, the same members in the latter being fuscous. There are thus three species well known of this genus; the *Cincl. aquaticus, Pallasii*, and *unicolor*, which latter name had been originally given by the Prince of Musignano to the American bird, on the supposition of its being distinct. The *Cincl. Mexicanus*, Swains., (Phil. Mag. July 1827), if not the same as the Rocky Mountain bird, as stated in the 'Annals of the Lyceum,' will form a fourth species.

A series of Birds belonging to this family were then exhibited, which Mr. Vigors referred to a group characterized by Dr. Horsfield and himself in the 15th volume of the 'Linnean Transactions,' under the name of *Cinclosoma*, the type of which was an Australian species, the *Turdus punctatus* of Dr. Latham. Mr. Vigors pointed out the characters that seemed to distinguish the *true Thrush*, or the type of the restricted genus *Turdus*, Auct.; which consist in a subacuminated wing, in which the first quill feather is extremely short, almost spurious, the second somewhat shorter than the third, and the third, fourth and fifth almost equal, and the longest; in the tail being even, and of moderate length; and in the *acrotarsia* or front covering of the *tarsi* being generally entire, or undivided by any perceptible scales. To this typical division of the family belong the *Throstle, Blackbird, Ring-Ouzel, Red-Wing, Fieldfare*, and *Missel Thrush* of Europe, the *migratory Thrush* of North America, the *Himalayan Blackbird* just described of India, the *varied Thrush* of New Holland, &c. &c. On the contrary, the group of *Cinclosoma*, while it exhibits the general characters of the bill of the *true Thrushes*, although partially modified in some of the species, displays an entirely different conformation of the wing and tail; the former of these members is comparatively short, and rounded, the first quill feather being of moderate length, the second, third, fourth, and fifth, gradually increasing in length; the fifth sixth, seventh and eighth, nearly equal; and the rest gradually decreasing; the tail at the same time being lengthened and graduated, as is usually the case in birds in which the wings are short and rounded. The scales also of the *acrotarsia* in *Cinclosoma* are conspicuously distinct. In this group the feathers are generally decomposed, as has been observed to be the case in the genus *Timalia*, Horsf., to which it bears a close affinity, and from which perhaps it can only be separated by the more short and arched beak of the latter group. Mr. Vigors observed that there were several Indian species which might be referred to this group. The four following, which were apparently hitherto undescribed, were then characterized as belonging to it.

CINCLOSOMA OCELLATUM. *Cinclos. capitis fronte et lateribus, corporeque suprà rufo-brunneis; vertice, colloque in fronte nigro-brunneis; pectore albescenti-rufo nigro fasciato; abdomine pallidè rufo, nuchâ, dorso, alis, caudæque tectricibus ocellis anticè atris*

atris posticè albis, notatis; remigibus et rectricibus lateralibus griseo-fuscis, apicibus albis.

*Rostrum pedes*que flavescentes, illius culmine fusco. *Remigum* mediarum pogonia externa grisea, strigam griseam alarem exhibentes. *Tectrices* alarum inferiores rufo nigro albescentique variegatæ. Longitudo *corporis*, 14; *alæ* a carpo ad remigis 6tæ apicem, 5; *rostri*, $1\frac{3}{10}$; *tarsi*, $1\frac{7}{10}$; *caudæ*, 7.

Cinclosoma capistratum. *Cinclos. capite supra, genis, pteromatum maculâ, rectricibusque ad basin intensè atris; remigum pogoniis externis, rectricum apicibus, tectricibusque alarum fusco-griseis, his fasciâ albâ notatis; dorso medio pallidè brunnescenti-griseo; collo in fronte, nuchâ, pectore, abdomineque summo pallidè, dorso abdomineque imis saturatiùs, rufis.*

Rostrum nigrum, *pedes* flavescentes. *Remiges* interiores, *rectricum*que mediarum bases rufi. Longitudo *corporis*, 10; *alæ* a carpo ad apicem remigis 6tæ, 4; *rostri*, $\frac{9}{10}$; *tarsi*, $1\frac{3}{20}$; *caudæ*, $4\frac{1}{2}$.

Cinclosoma variegatum. *Cinclos. strigâ a rictu per oculos extendente, mento colloque in fronte, maculâ pteromatum et mediâ alarum, rectricumque mediarum basibus atris; fronte, strigâ genarum infrà, pectoreque pallidè albescenti-rufis; notâ pteromatum, abdomine crissoque rufis; capite suprà, nuchâ, dorsoque brunnescenti-griseis; alarum pogoniis externis, rectricumque mediarum quatuor apicibus cineraceo-griseis; rectricibus quatuor utrinque lateralibus externè flavo-olivaceis, apicibus albis.*

Rostrum nigrum, *pedes* rubri. Longitudo *corporis*, 11; *alæ* a carpo ad apicem remigis 6tæ, 4; *rostri*, $\frac{9}{10}$; *tarsi*, $1\frac{3}{10}$; *caudæ*, $4\frac{1}{2}$.

Cinclosoma lineatum. *Cinclos. capite suprà, nuchâ, dorso imo, rectricibusque duabus mediis brunnescenti-griseis; regione postoculari, dorso summo, corpore infrà, rectricibusque lateralibus pallescenti-rufis; his fasciâ nigrâ pone apicem album notatis; capitis nuchæque plumis in medio lineis fuscis, pectoris dorsique summi lineis pallidis, per totam rhachium longitudinem graciliter strigatis.*

*Rostrum pedes*que flavescentes. Longitudo *corporis*, $9\frac{1}{2}$; *alæ* a carpo ad apicem remigis 6tæ, $3\frac{1}{2}$; *rostri*, $\frac{7}{10}$; *tarsi*, 1; *caudæ*, $3\frac{3}{4}$.

April 12, 1831. N. A. Vigors, Esq., in the Chair.

Mr. Coleman, adverting to the statement made at the last meeting of the Committee that the female *Armadillo* had destroyed her young, remarked that the cause of this apparent aberration of instinct in a mother was generally to be found in the deficiency of her supply of milk. In the many cases which had fallen under his notice, in which female pigs, rabbits, and other domesticated animals had destroyed their progeny, he had always observed that the secretion of milk in the mammary glands of the dam was greatly, if not entirely, deficient.

A letter was read from M. F. Cuvier, acknowledging the receipt of the Society's circular, and embracing the offer contained in it of establishing

establishing a scientific correspondence. M. F. Cuvier states that the zoological subjects which possess at the present moment the greatest interest in Paris are those which have been transmitted from Chili, by M. D'Orbigny, who is now engaged in travelling on account of the Jardin des Plantes. M. F. Cuvier has not yet examined them with care; but he has observed among them a large *Rodent* animal, which is probably the *Patagonian Cavy* of Pennant, a species unknown to later zoologists: it forms the type of a new genus allied to *Anœma* and *Kerodon*, its teeth having nearly the form of those of the last-mentioned group, and being without distinct roots. He has also remarked a very small species of *Ratel*, distinguished from the type of the genus, as it exists in the old continent, by having two false molar teeth less in each jaw: it is also much smaller, its size not exceeding that of the *Pole-cat*, (*Mustela putorius*, L.) It is remarkable, he adds, that in Chili, the southern extremity of America, a second species should at length be found of a genus hitherto met with only in Africa and in India. "If Buffon had been acquainted with this fact, he would have had a fine example to adduce in favour of his hypothesis of the diminutive size of the animals of the New World, as compared with those of the Old." The Jardin des Plantes has recently obtained living individuals of the small *Deer* of America, named by M. F. Cuvier *Cervus campestris;* this will shortly be figured in his 'Histoire Naturelle des Mammifères.' Two other *Deer* have been presented to the collection by M. Dussumier, by whom they were brought from Timor: these appear to belong to two new species. From Madagascar, M. Goudot has brought a small carnivorous animal, which he states to be the true *Vansire*. The *cranium* of a very young specimen agrees closely with that of a very young individual of the *Gulo orientalis*, Horsf.; and as these *crania* in their general structure and their system of dentition differ from those of the genus *Gulo*, and approach the *crania* of the *Viverridæ*, it is probable, M. F. Cuvier remarks, that the *Gulo orientalis*, and M. Goudot's animal, should both be referred to the family of *Civets*.

At the request of the Chairman, the following Notes of the dissection of the *Ruffed Lemur* (*Lemur Macaco*, L.,) were read by Mr. Martin.

"The *Ruffed Lemur* which died lately in the Museum was a male, and one of a fine pair recently brought to this country. It exhibited marked symptoms of illness a few days only before its death, but had probably been long diseased.

"On the *abdomen* being opened, the *viscera* presented themselves as follows. In the epigastric and hypochondriac regions, stretching from side to side, appeared the liver, and below this the stomach, and the *omentum* loaded with fat, extending to the *pubes*, and covering the whole of the intestines. On turning aside the *omentum* and intestines the spleen was observed; it was large, dark coloured, bound by adhesions to the surface of the kidneys, and studded with numerous small *vomicæ*, from which, on cutting, a thick *pus* oozed out abundantly.

"The

"The liver was trilobed, deeply divided, of a pale colour, singularly mottled with red, and indurated: on cutting into it, the same paleness was found to obtain, joined to a sort of granulated appearance and fracture. The gall-bladder was small, and contained no bile, to the secretion of which the liver was probably of late inadequate. The *ductus choledochus communis* entered four inches from the *pylorus*.

"The intestines were pale and flaccid with extensive adhesions both of these and the mesentery, affording proofs of inflammatory action. The length of the *colon* and *rectum* was two feet; that of the *cæcum* thirteen inches; the shape of the latter was not unlike that of a horn, its base being broad, from whence it gradually tapered to a point, with spiral gyrations on the mesentery. The small intestines measured 5 feet 4½ inches.

"The cavity of the chest was relatively small, that of the *abdomen* advancing high. The lungs were divided into three lobes on the left, and three large and one small lobe on the right side. Their surface afforded strong indications of inflammation, and their substance when squeezed between the fingers communicated a very distinct *crepitus*. The heart was large, and tolerably firm; on the surface of the right ventricle there were two hydatids in a line one above the other.

"The kidneys were rather large, and their structure soft and pulpy. The *testes* were small, elongated, lying in front of the *pubes* and distant from the abdominal ring about one inch. The bladder was small and long; and the ureters entered about a line from the neck. The *vesiculæ seminales* were small and handle-shaped, with a single turn.

"The tongue was long, thin, rounded at the tip, of a black colour except at the root, soft in texture, and covered with downy *papillæ*, which increased in size and length, but diminished in number, towards the root. The *epiglottis* was large and broad; the *rima glottidis* long; and from the arytenoid cartilages two processes extended backwards, having a triangular flattened surface ending in a point."

The body of one of the Society's specimens of the *Razor-billed Curassow*, (*Ourax Mitu*, Cuv.,) was laid on the table, and Mr. Yarrell pointed out the peculiarities of its very elongated *trachea*, which is produced between the skin and the muscles beyond the *sternum*, and reaches almost to the vent. It has been figured by Dr. Latham, M. Temminck, and others. Mr. Yarrell displayed the sterno-tracheal muscles extending along the whole of the tube, and remarked that this disposition prevails, with one or two exceptions, in all birds in which the fold of the *trachea* is not included in bone. In those birds, on the contrary, in which the prolongation of the *trachea* enters a cavity in the *sternum*, (as for instance in the *Hoopers Cygnus ferus* and *Cygn. Bewickii*,) the sterno-tracheal muscles pass from the entering portion of the tube to that which has just left the bone, and are not continued along the fold of *trachea* included within the bone.

 A por-

A portion of a large collection of Fishes from the Mauritius, presented to the Society by Mr. Telfair, was exhibited; and Mr. Bennett called the attention of the Committee to the species of *Mullet* contained in it. These were eight in number, and belonged to the extra-European form to which the name of *Upeneus* has been given by M. Cuvier, and which is distinguished from the European *Mullets* by the presence of teeth in the upper jaw. Four of these fishes appear to have been previously undescribed, and may be thus characterized:

Upeneus bitæniatus. *Up. dentibus velutinis apud maxillas, vomerem, et ossa palatina: capite pone oculos subdepresso: pinnis dorsalibus caudalique nigro obliquè fasciatis; corpore toto rubicundo, dorso argenteo-vittato, vittis duabus aureis infrà lineam lateralem.*

D. 7, $\frac{1}{8}$. A. $\frac{1}{6}$. C. 15. P. 16. V. $\frac{1}{5}$.

Affinis *Up. vittato*, Cuv. & Val.: sed differt vittis duabus aureis; differt etiam vertice depresso rostroque subtumido, capite haud æqualiter rotundato.

Upeneus Mauritianus. *Up. dentibus velutinis maxillaribus: rostro brevi, orbitæ subæquali: pinnis dorsali secundâ analique declivibus.*

D. 7, $\frac{1}{8}$. A. $\frac{1}{7}$. C. 15. P. 16. V. $\frac{1}{5}$.

Affinis *Up. flavo-lineato*, Cuv. & Val.: brevior est, rostrumque multo brevius, in illo nempe orbitæ sesquidiametrum æquat.

Upeneus pleurostigma. *Up. dentibus conicis maxillaribus: corpore pinnisque (præter dorsali 2dâ analique) cinnabarinis; maculâ magnâ rotundatâ laterali mediâ nigrâ; punctis plurimis infra et post oculos aureis.*

D. 8, $\frac{1}{8}$. A. $\frac{1}{7}$. C. 15. P. 16. V. $\frac{1}{5}$.

Affinis *Up. lateristrigæ*, Cuv. & Val. Caput rotundatum sicut in *Mullo Surmuleto*, L.

Upeneus immaculatus. *Up. dentibus conicis maxillaribus distantibus: corpore, basi anteriore pinnæ dorsalis prioris, apiceque lobi inferioris caudalis, cinnabarinis: cirris albis, ultra operculum productis.*

D. 8, $\frac{1}{8}$. A. $\frac{1}{6}$. C. 15. P. 16. V. $\frac{1}{5}$.

Affinis *Up. chryserydro*, Cuv. & Val.: sed corpus duplò latius, rostrumque magis declive.

The species characterized embrace instances of three of the distinct types of dentition indicated in this genus by MM. Cuvier and Valenciennes.

The original drawings by Mr. Abbott of the Lepidopterous Insects of Georgia, (engravings from which were published by the late Sir J. E. Smith,) were exhibited. The Committee was indebted to Mr. Henry Brogden, F.L.S. for this exhibition.

Mr. Vigors referred to a pair of *Owls* which had been lately added to the Society's collection. These were closely allied to the European *Strix flammea*, a species which is found with some slight modifications of character all over the globe; but from which the present species differs essentially, exclusively of other characters, by the

the markings of the disk of the face. They were from Australia; and not having appeared to have been noticed by any ornithological writer were characterized as follows.

Strix personata. *Strix pallidè badia; capite suprà, dorso, alisque fusco brunneo variegatis, albisque guttulis parcè sparsis; corpore infrà pallidiori, brunneo parcè maculato; caudâ badio brunneoque undulatim fasciatâ; disco purpurascenti-badio, circulo marginali intensè brunneo notato; digitis unguibusque fortissimis.*

Longitudo *corporis*, 13½; *alæ* a carpo ad apicem remigis 2dæ, 9; *tarsi*, 2; *caudæ*, 7½.

A series of birds, belonging to several Families, which were apparently undescribed species, was exhibited by Mr. Leadbeater who mentioned his intention of continuing a similar exhibition during some future meetings of the Committee, and then giving a general description of the whole.

LINNÆAN SOCIETY.

May 24.—A. B. Lambert, Esq., V.P., in the Chair. This day being the Anniversary, the following Officers and Council were elected for the ensuing year.

President: Edward Lord Stanley, M.P.— *Treasurer:* Edward Forster, Esq. F.R.S.—*Secretary:* J. E. Bicheno, Esq. F.R.S.—*Under Secretary:* Richard Taylor, Esq. F.S.A.—Also to fill the five vacancies in the Council: George Henry Lord Bishop of Bath and Wells; William John Burchell, Esq.; Captain Phillip Parker King, R.N.; John Morgan, Esq.; Whitlock Nicholl, M.D.—Many of the Members afterwards dined together at the Freemasons Tavern.

FRIDAY-EVENING PROCEEDINGS AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

April 15.—Mr. John F. Daniell on the forms and attractions of the particles of Crystals. Mr. Daniell gave a comprehensive and illustrated view of the theories of polyhedral and spherical or spheroidal particles, showed their consistency with each other, and drew some new arguments in support of the latter from the recent experiments of Mitscherlich and himself.

April 22.—Mr. Marshall on the origin and utility of Cow-pox, with the causes of failure in the practice of vaccination.

April 29.—Mr. Faraday on Mr. Trevelyan's recent experiments on the production of Sound during the conduction of Heat. Mr. Faraday gave his view of the minute action of the parts producing this curious effect; he referred the effect to the expansion and contraction of the colder metal as others had done; but he pointed out minutely the direction and disposition of the forces, by which such changes in bulk were enabled to produce the phænomenon in question.

May 6.—Mr. Lindley on the Pitcher Plant. Mr. Lindley described

scribed three species of the pitcher plant; and then taking a view of the metamorphoses of certain parts of plants, endeavoured to show what the pitchers really were, and what were their probable uses.

May 13.—Mr. Brockedon on the passage of the Alps by Hannibal. Mr. Brockedon, from his extensive personal knowledge of the Alps, was enabled to review the accounts given of this passage, and to draw conclusions as to the true locality of the passage, which he believes took place over the little St. Gothard.

May 20.—Mr. Robertson on a new practice of Painting, which unites the force of other modes with extreme durability. Mr. Robertson's paintings are in water-colours, and upon paper. He uses isinglass dissolved in hot spirit of wine between and over his colours, by which they acquire the brilliancy and force of oil; and when the picture is finished, he covers it with a colourless copal varnish. The pictures when large are lined with canvass and tin-foil. The durability and steadfastness of the colours appear to be extreme.

CAMBRIDGE PHILOSOPHICAL SOCIETY.

A meeting of the Philosophical Society was held on Monday evening, May the 9th, Dr. F. Thackeray, the Treasurer, in the chair.

There were presented to the Society a specimen of the Squacco Heron, by Mr. Price of St. John's College, and a very fine Coralline, from Madeira, by Mr. Lowe of St. John's College.—A paper by Mr. Pritchard of St. John's College was read, "On a method of simplifying the investigation of the figure of the earth considered as heterogeneous." The remainder of a paper by Professor Whewell was also read, "On the mathematical exposition of the leading doctrines in Mr. Ricardo's Principles of Political Œconomy and Taxation." It was shown that Mr. Ricardo's proposition, that a tax upon wages must necessarily fall upon profits, cannot be maintained on his own principles. When stated mathematically, the question leads to an indeterminate problem, in which the rise of price and the fall of profits mutually depend on each other, and neither can be determined without some further assumption. Similar modes of investigation were then applied to the doctrine of exports and imports, and the different value of the money-metals in different countries, in consequence of their influx and efflux produced by manufacturing skill and other causes. Finally, formulæ were given on which, according to such principles, the rate of exchange will depend. Mr. Whewell concluded by observing that he did not put forward such formulæ as applicable to practice, but as exhibiting the results of Mr. Ricardo's theories: and that if the principles were true and certain, mathematics would be the proper instrument for obtaining their consequences.

After the meeting Mr. Willis exhibited a numerous and curious series of experiments upon the subject of sound. Among these were, first, the experiment (originally made by Hooke) of the production of the definite musical sound by the impulses of the teeth of a revolving wheel upon a card; by means of which contrivance the

the rapidity of vibration of a given sound may be determined. This proceeding has recently been proposed anew by M. Savart.—Mr. Willis produced also an invention of Professor Robison, in which a definite sound is emitted by a stop-cock through which a stream of air passes, interrupted at regular small intervals. An invention similar to this has been put in other forms by M. Cagniard de la Tour, one of which forms is the instrument which he has called the *Syren*. A machine of Mr. Willis's invention was exhibited (which he proposes to call a *Lyophone*) by means of which is appeared that the sound in such cases is produced not by the periodical interruption of the current of air, but by the close recurrence of small noises; it was likewise shown that by various dispositions of the holes through which the air passes, two or more sounds may be brought out at the same time. Mr. Willis repeated also some of M. Savart's experiments on *embouchures*, and showed, contrary to the opinion expressed by that gentleman, that when air passes through a narrow slit against an edge, the note is not affected by the angle or material of the edge, or by the angle of the air; but only by the distance of the edge and its want of centrality; the effect of such embouchures when used in organ-pipes, and the manner in which the note appears in these cases to be determined, partly by the embouchure and partly by the pipe, was shown by trial.—There were exhibited, likewise, some experiments manifesting the nature of the vibrations in the sounding-boards and bridges of violins, the office and effect of the sound-post, and the form which M. Savart, in virtue of his own views, is disposed to recommend for this instrument.

LXVII. *Intelligence and Miscellaneous Articles.*

MR. GALBRAITH ON AN OMISSION IN HIS PAPER ON NORTH POLAR DISTANCES.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN my paper, published in the Philosophical Magazine for May last, there has occurred an omission, which I request you to supply as early as possible.

The table was computed for the zenith distance, and therefore cannot answer for the north polar distance without either forming two tables, or using a *constant* with one table. The latter plan I preferred, by making the corrections for north polar distance to the north of Greenwich negative, and applying the constant $+0''\cdot53$ throughout the whole table. The second part of the table or zenith distance south gives still the correction in zenith distance without the constant, and may be useful where that is required; and thus both purposes are served: the particular I had in view when I gave the table double arguments. From the time I had drawn up the table till that when I wrote the explanation and examples of application, this circumstance escaped me, which has

has led to the oversight. Each of the results should therefore be increased by $+0''\cdot53$, or,

	°	′	″
Polaris (correct)................	1	31	51·40
Spica Virginis..................	100	16	14·79
Antares........................	116	2	45·43

which still further reduces the differences from Bessel's Catalogue.

It would therefore be well for such as may be inclined to use the table, to insert with a pen above it—

Constant for North Polar Distance $+0''\cdot53$.

I am, Gentlemen, your obedient Servant,

54, South Bridge, Edinburgh, May 6, 1831. Wm. Galbraith.

LUNAR OCCULTATIONS.

Occultations of Planets and fixed Stars by the Moon, in June 1831. *Computed for Greenwich, by* Thomas Henderson, *Esq.; and circulated by the Astronomical Society.*

1831.	Stars' Names.	Magnitude.	Ast. Soc. Cat. No.	Immersions.				Emersions.			
				Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.	Sidereal time.	Mean solar time.	Angle from North Pole.	Angle from Vertex.
				h m	h m	°	°	h m	h m	°	°
June 1	IV. Sat. Jup.	...	...	17 28	12 49	75	40	18 31	13 52	311	284
	II. Sat. Jup.	...	...	17 44	13 5	79	46	18 50	14 11	307	282
	Jupiter......	...	...	17 46	13 6	80	47	18 52	14 12	306	281
	I. Sat. Jup.	...	...	17 49	13 10	81	49	18 55	14 16	305	280
	III. Sat Jup.	...	...	17 53	13 14	82	50	19 0	14 21	304	280
9	Aldebaran	1	528	6 43	1 34	96	126	7 49	2 40	284	322
19	94 Virginis	6	1605	18 25	12 35	38	73	19 18	13 28	288	326
21	γ Libræ	4·5	1764	15 10	9 13	100	97	16 23	10 25	222	231
30	χ Aquarii..	5·6	2776	19 38	13 4	111	79	20 50	14 17	291	268

METEOROLOGICAL OBSERVATIONS FOR APRIL 1831.

Gosport:—Numerical Results for the Month.

Barom. Max. 30·420. April 1. Wind N.E.—Min. 29·195. April 29. Wind S. Range of the mercury 1·225.

Mean barometrical pressure for the month .... 29·732

Spaces described by the rising and falling of the mercury............ 4·745

Greatest variation in 24 hours 0·370.—Number of changes 14.

Therm. Max. 68°. April 13. Wind N.W.—Min. 32°. April 4. Wind S.E. Range 36°.—Mean temp. of exter. air 51°·25. For 31 days with ☉ in ♈ 48·26

Max. var. in 24 hours 24°·00.—Mean temp. of spring-water at 8 A.M. 49·14

De Luc's

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere, in the evening of the 9th	95°
Greatest dryness of the atmosphere, in the afternoon of the 20th...	46
Range of the index	49
Mean at 2 P.M. 61°·2.—Mean at 8 A.M. 69°·3.—Mean at 8 P.M.	73·5
—— of three observations each day at 8, 2, and 8 o'clock	68·0

Evaporation for the month 3·65 inches.
Rain in the pluviameter near the ground 2·525 inches.
Prevailing winds, N.E. and S.

Summary of the Weather.

A clear sky, $3\frac{1}{2}$; fine, with various modifications of clouds, $15\frac{1}{2}$; an overcast sky without rain, 6; rain, 5.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
17	11	28	0	18	16	13

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	$6\frac{1}{2}$	2	4	6	3	3	$3\frac{1}{2}$	30

General Observations.—This month has been generally fine and mild, with the exception of a few days. The refreshing showers at intervals, aided by the sun's influence in his progress northward, have quickened vegetation; also the blooming of the fruit trees in the order of their time throughout the month, and the blossoms are profuse. Since the late rains the grass fields and young wheat have much improved, and the former have resumed their verdure and gaiety. These operations, now Nature has revived from the sleep of winter, and the vegetable world from torpor to animation, proceed rapidly, and afford to a close observer not only an inexpressible pleasure, but a consciousness of the constancy of an unerring Providence; and we may rely on the promise that has hitherto been annually fulfilled, "While the earth remaineth, seed-time and harvest shall not cease."

In the evening of the 12th instant, lightning emanated from the clouds from eight till ten o'clock. Soon after sunset on the 13th, the small crescent of the moon was conspicuous about six degrees above the western horizon, being less than twenty-eight hours from the time of her change. On the morning of the 17th a few swallows appeared for the first time since their departure.

At one P.M. on the 22nd, a storm came on suddenly, and deposited six-tenths of an inch of rain in the pluviameter in less than half an hour: the rain descended in torrents about five minutes, and some of the accompanying hailstones were half an inch in diameter, with icy *nuclei.* The storm was occasioned by two winds, one from the North-east, the other from the South, and the consequent inosculation of clouds of different temperatures from these points of the compass. No rain or hail fell at Portchester, about four miles distant.

Between one and two o'clock in the afternoon of the 23rd, a storm of rain, hail, and wind came on from the North-east, accompanied with several strong flashes of lightning and reverberating peals of thunder. Some of the hailstones measured seven-tenths of an inch in diameter, but were mostly angular pieces of ice. The storm came on under nearly the same circumstances as that of yesterday.

The mean temperature of the external air this month is about one degree and a quarter higher than the mean of April for many years.

The atmospheric and meteoric phænomena that have come within our observations this month, are one solar and one lunar halo, six meteors, lightning

lightning on two days, and thunder on one, two auroræ boreales, and seven gales of wind, or days on which they have prevailed, namely, two from the North-east, one from the East, and four from the S.W.

Auroræ Boreales.—From half-past eight P.M. in the evening of the 19th till one A.M., an aurora borealis appeared in the strong moonlight. The streamers or columns of light began to ascend soon after nine; and at twenty minutes past, the under edge of the aurora was best defined, when its vertex in the magnetic north was $13\frac{1}{2}$ degrees above the northern horizon, and at that time a perfect detached arch of the effluvium gradually rose and disappeared. At forty minutes past nine there was a grand display of about ten long active streamers along the under arch of the aurora, several of which ascended to an altitude of 60 degrees; and at a quarter before ten, when they were most active, many passed beyond the zenith through the square and tail of Ursa Major, exhibiting at the same time several prismatic colours. At ten o'clock the arch of the aurora extended 150 degrees, and one of the coloured streamers, which rose from the western point of the horizon, with a considerable inclination to the South, passed over the moon, so that her light had but little effect over its red colour, except in her immediate vicinity. The aurora now began to sink gradually, but the red columns continued to rise at short intervals. At twelve o'clock a *cirrocumulus* cloud sprang up from the North-east, in a uniform arrangement of white flocks, and spread over the whole visible hemisphere. After it had passed off, the streamers were again very active, particularly in the North-east quarter, till one o'clock. One meteor appeared over the aurora at ten o'clock, and the air was dry, with a clear sky nearly the whole of the time.

From a quarter past ten till twelve P.M. in the night of the 20th, parts of an arch of light were frequently formed instantaneously by a turbid coloured fluid. The whole arch, extending from North-west by West to North-east by North, was formed at intervals, but not more than 20 degrees or 25 degrees at a time, and it soon disappeared: its edge often coincided with β Cassiopeia, then under Polaris, making its altitude about 20 degrees. These sudden fits of light, about two degrees in width, were not produced by any perceptible streamers of an aurora, but they must have emanated from one under the horizon, and the coruscations in that case acted horizontally in strong moon-light. Two bright meteors appeared over it.

REMARKS.

London. — April 1. Fine: rain at night. 2. Cloudy: rain. 3. Fine. 4. Overcast: slight fog with frost at night. 5—7. Fine. 8. Heavy rain. 9. Cloudy: rain. 10, 11. Fine. 12. Cloudy: thunder with rain at night. 13, 14. Fine. 15, 16. Overcast. 17. Hazy. 18. Fine. 19. Fine: splendid aurora borealis in the evening. 20. Fine. 21. Slight haze: fine. 22. Fine. 23. Cloudy: thunder at noon. 24—26. Fine. 27. Slight rain: fine. 28. Mild showers. 29. Rain, with intervals of warm sun. 30. Fine in the morning: cloudy.

Penzance.—April 1. Clear. 2. Rain. 3, 4. Fair. 5. Clear. 6. Fair. 7. Fair: rain. 8. Fair: showers. 9—11. Fair. 12. Fair: showers. 13—21. Fair. 22. Fair: showers. 23, 24. Fair. 25. Rain: fair. 26. Fair. 27. Fair: rain. 28. Fair. 29. Rain. 30. Fair.

Boston. — April 1. Fine. 2. Cloudy: rain early A.M. 3. Cloudy. 4—7. Fine. 8. Rain. 9—11. Fine. 12—17. Cloudy. 18. Fine. 19—25. Cloudy. 26. Fine. 27. Cloudy. 28. Rain. 29, 30. Cloudy.

Meteoro-

Meteorological Observations made by Mr. Thompson at the Garden of the Horticultural Society at Chiswick, near London; by Mr. Giddy at Penzance, Dr. Burney at Gosport, and Mr. Veall at Boston.

Days of Month, 1831.	Barometer. London. Max.	Barometer. London. Min.	Barometer. Penzance. Max.	Barometer. Penzance. Min.	Barometer. Gosport. Max.	Barometer. Gosport. Min.	Barometer. Boston 8½ A.M.	Thermometer. London. Max.	Thermometer. London. Min.	Thermometer. Penzance. Max.	Thermometer. Penzance. Min.	Thermometer. Gosport. Max.	Thermometer. Gosport. Min.	Thermometer. Bost. 8½ A.M.	Wind. Lond.	Wind. Penz.	Wind. Gosp.	Wind. Bost.	Evap. Gosp.	Rain. Lond.	Rain. Penz.	Rain. Gosp.	Rain. Bost.
April 1	30·470	30·233	30·00	29·98	30·420	30·305	30·20	60	37	48	36	48	36	46	NE.	NE.	NE.	calm	...	0·05	...	0·020	...
2	30·108	30·034	29·90	29·88	30·068	30·009	29·75	59	36	45	36	48	43	43	NE.	NE.	E.	calm	...	·46	0·440	...	0·18
3	30·001	29·846	29·88	29·80	29·936	29·829	29·66	60	34	50	37	51	38	42·5	NE.	NE.	NE.	calm	0·40	...	...	...	...
4	29·751	29·584	29·70	29·65	29·740	29·629	29·34	55	31	51	44	53	32	39	NE.	SE.	NE.	N.	...	...	...	...	...
☾ 5	29·584	29·502	29·55	29·55	29·581	29·539	29·05	56	38	53	38	56	40	46	W.	NW.	W.	NW.	...	...	...	...	...
6	29·534	29·481	29·55	29·50	29·573	29·503	28·96	58	39	54	44	56	43	50	S.	W.	W.	calm	·25	...	...	...	...
7	29·397	29·300	29·25	29·10	29·358	29·286	28·92	63	47	54	47	55	48	48·5	SE.	SW.	SE.	calm	...	·20	·420	·400	...
8	29·433	29·291	29·10	29·10	29·328	29·296	28·72	54	45	55	44	50	48	50	S.	S.	S.	W.	...	·40	·070	·250	·32
9	29·546	29·500	29·35	29·30	29·548	29·493	29·02	61	46	56	46	56	47	52	S.	S.	S.	W.	·20	·26	...	·210	...
10	29·857	29·585	29·52	29·40	29·808	29·639	29·06	58	35	59	45	58	42	53	W.	SE.	SW.	W.	...	...	...	...	...
11	30·019	29·980	29·63	29·63	29·972	29·943	29·48	58	46	62	42	61	50	52·5	NE.	E.	NE.	W.	...	...	...	...	...
● 12	29·936	29·822	29·57	29·51	29·888	29·803	29·45	66	44	64	49	63	49	52	E.	SE.	E.	E.	·35	·15	...	·050	...
13	29·835	29·801	29·58	29·54	29·827	29·762	29·31	69	47	60	47	68	48	55	N.	NE.	NW.	calm	...	...	...	...	...
14	30·004	29·979	29·77	29·73	30·021	29·981	29·30	58	39	59	48	57	42	53	N.	NE.	N.	N.	...	...	...	...	...
15	30·038	30·000	29·81	29·81	30·053	30·025	29·42	60	49	63	46	58	49	52	NW.	NE.	NW.	W.	·50	...	...	...	...
16	30·070	30·002	29·83	29·79	30·055	30·005	29·50	61	47	63	48	59	48	52·5	NE.	E.	NW.	calm	...	...	...	...	...
17	30·058	29·996	29·77	29·77	30·000	29·972	29·50	56	34	55	45	61	39	50	NE.	NE.	SE.	calm	...	...	...	...	...
18	30·074	30·007	29·78	29·77	30·069	29·985	29·59	58	38	58	45	58	40	51	NE.	E.	N.	calm	·40	...	...	...	...
☽ 19	29·981	29·897	29·73	29·67	29·973	29·900	29·54	62	39	60	43	60	43	45	NE.	E.	NE.	calm	...	...	...	...	...
20	29·837	29·717	29·57	29·42	29·826	29·700	29·40	59	41	60	48	62	42	43·5	NE.	SE.	NE.	E.	...	...	...	...	...
21	29·559	29·494	29·34	29·34	29·581	29·476	29·12	55	45	57	45	56	47	50	E.	SE.	SE.	NE.	·55	...	...	...	...
22	29·506	29·387	29·29	29·27	29·521	29·431	29·05	65	45	60	46	61	47	53	E.	NE.	SE.	E.	...	...	...	·915	...
23	29·705	29·504	29·38	29·37	29·653	29·516	29·10	61	48	55	48	60	42	54	E.	NE.	NE.	calm	...	...	...	·120	...
24	29·931	29·844	29·64	29·60	29·960	29·866	29·32	63	52	62	46	60	46	52	S.	NW.	NW.	calm	·45	...	...	...	...
25	30·010	29·953	29·80	29·69	30·003	29·968	29·51	66	42	55	47	61	50	51·5	S.	SW.	W.	calm	...	...	...	·020	...
26	29·820	29·777	29·80	29·80	29·808	29·753	29·35	65	42	55	49	55	48	54	S.	NW.	S.	calm	...	·01	·540	·120	...
○ 27	29·665	29·465	29·60	29·50	29·623	29·503	29·12	63	47	56	45	59	49	51	S.	SW.	SW.	calm	·15	·04	·360	·040	...
28	29·354	29·306	29·35	29·30	29·354	29·335	28·87	57	40	57	46	62	47	51	SE.	W.	S.	calm	...	·10	...	·190	...
29	29·242	29·209	28·95	28·90	29·258	29·195	28·76	65	48	55	45	61	49	52·5	SE.	W.	SW.	calm	...	·30	·265	·175	·40
30	29·266	29·239	29·20	29·10	29·310	29·208	28·76	67	45	60	44	60	50	53	S.	W.	SE.	W.	·40	...	...	·015	...
	30·470	29·209	30·00	28·90	30·420	29·195	29·27	69	31	64	36	68	32	49·9					3·65	1·97	·095	2·525	0·90

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END OF THE NINTH VOLUME.

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